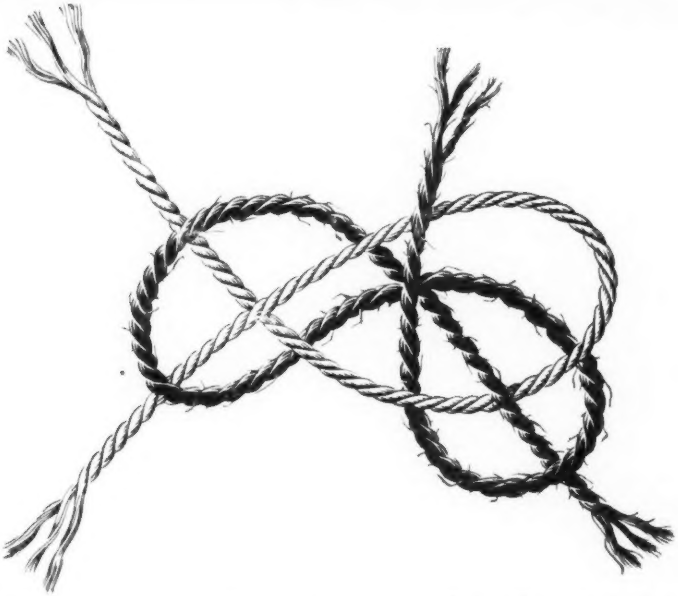
12 JUNE 1959

METAL INDUSTRY

THE JOURNAL OF NON-FERROUS METALS



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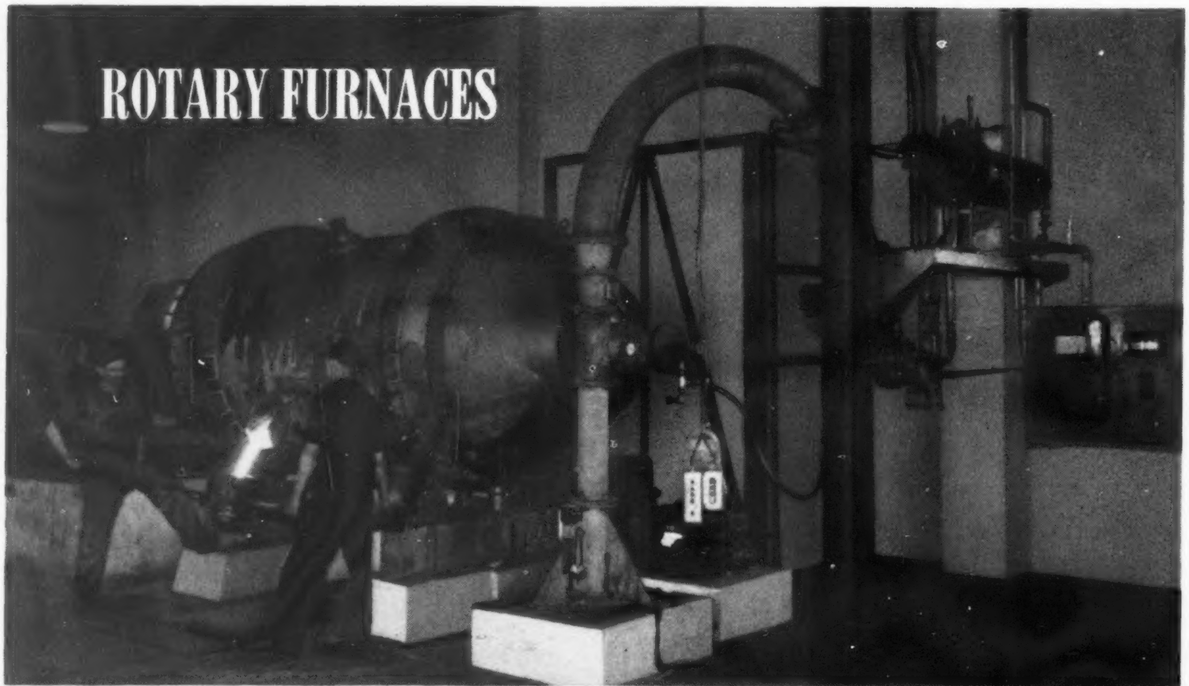

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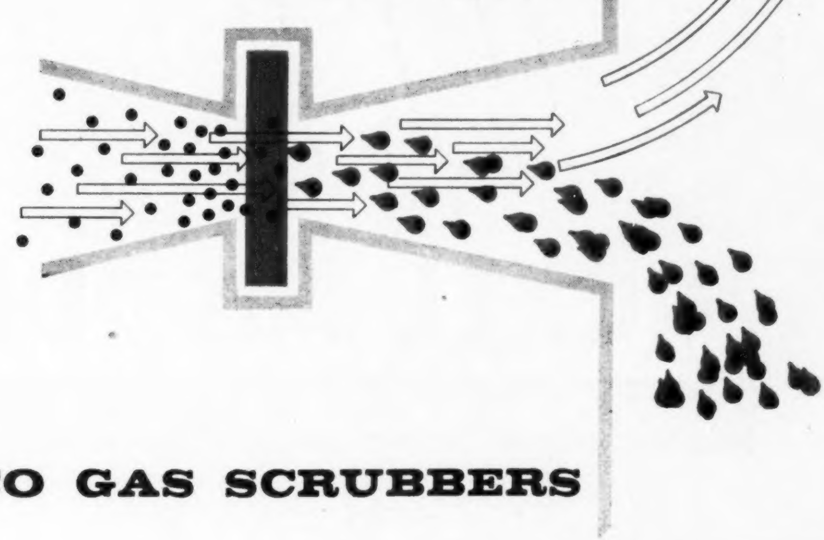

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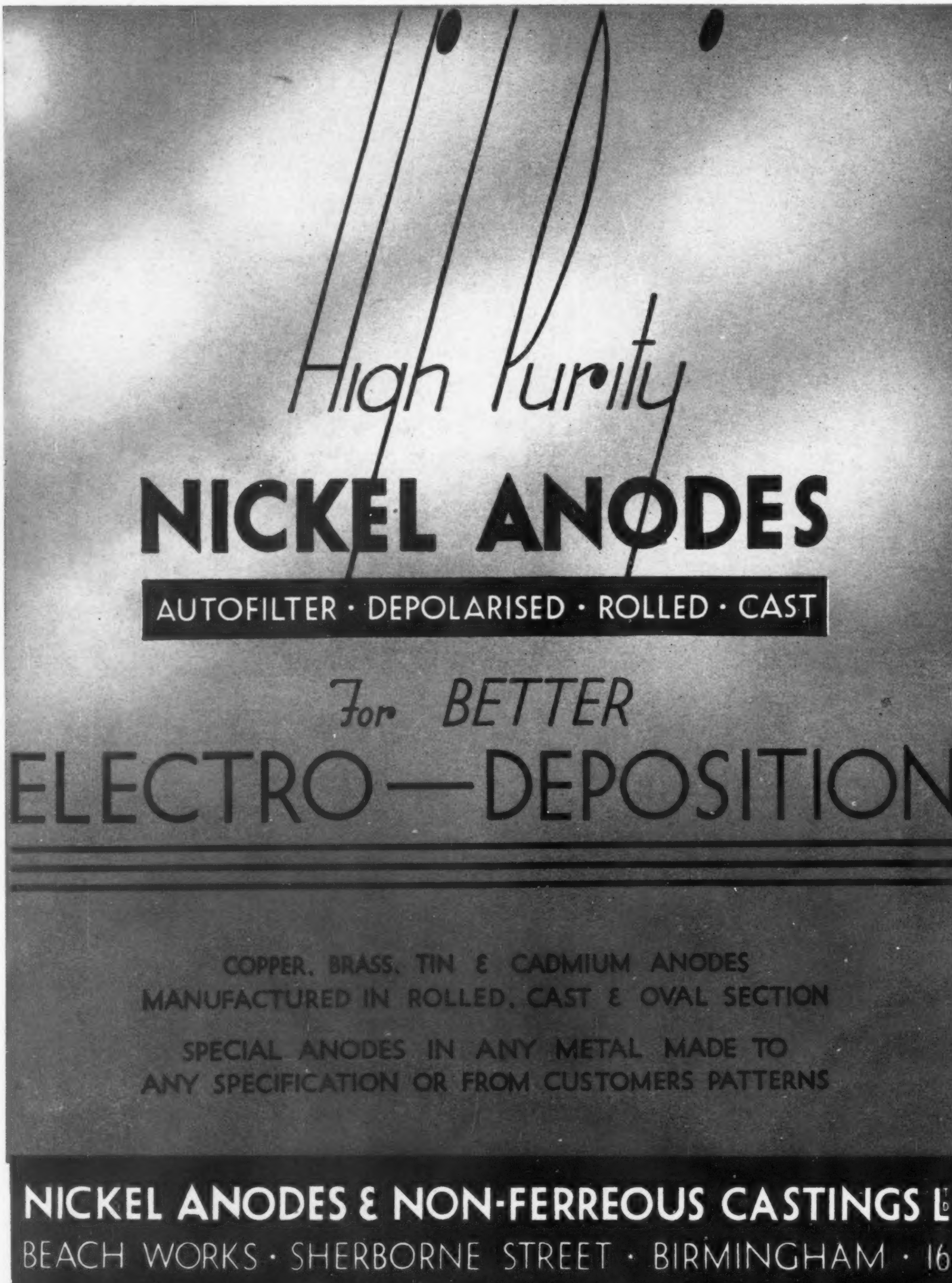
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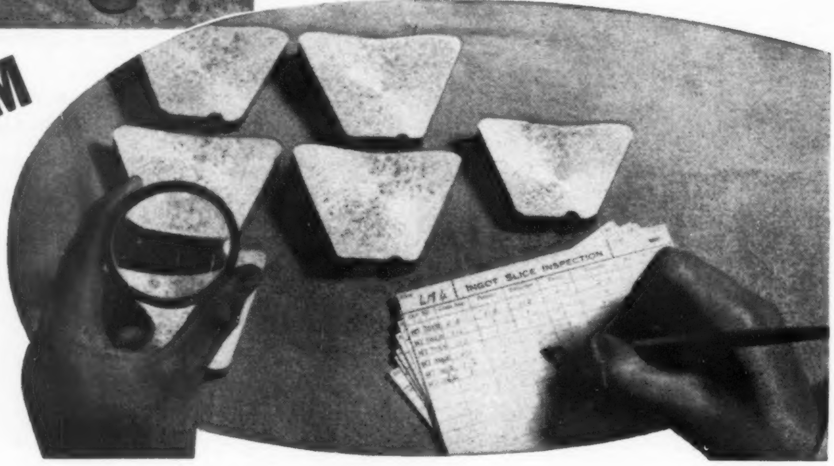

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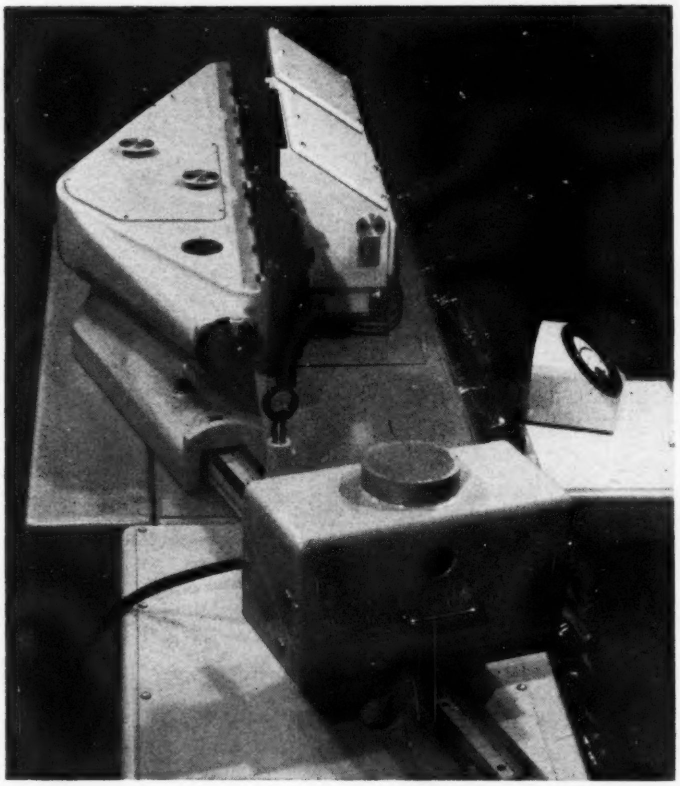

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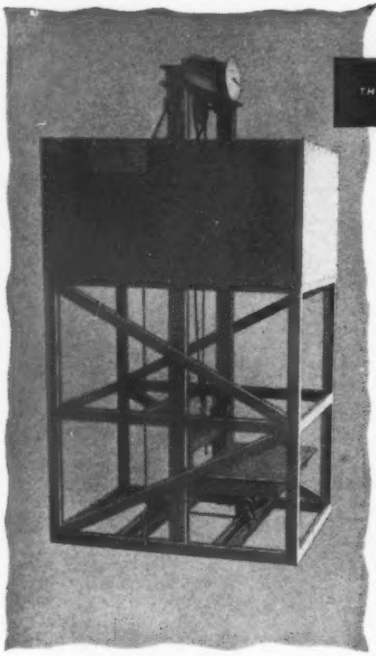

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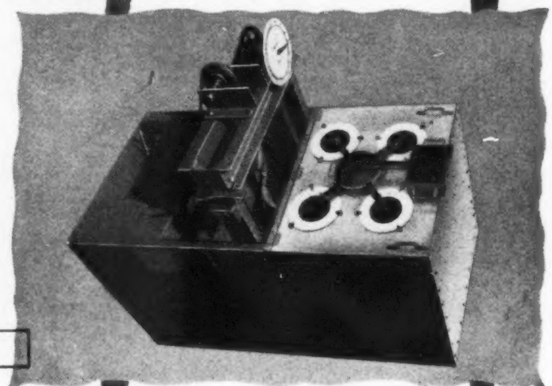

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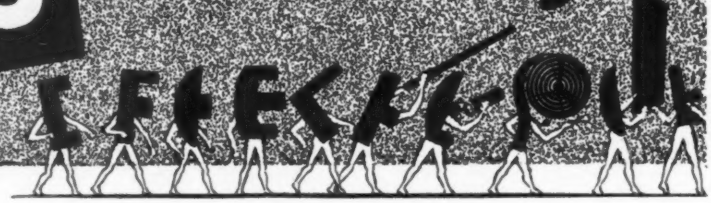

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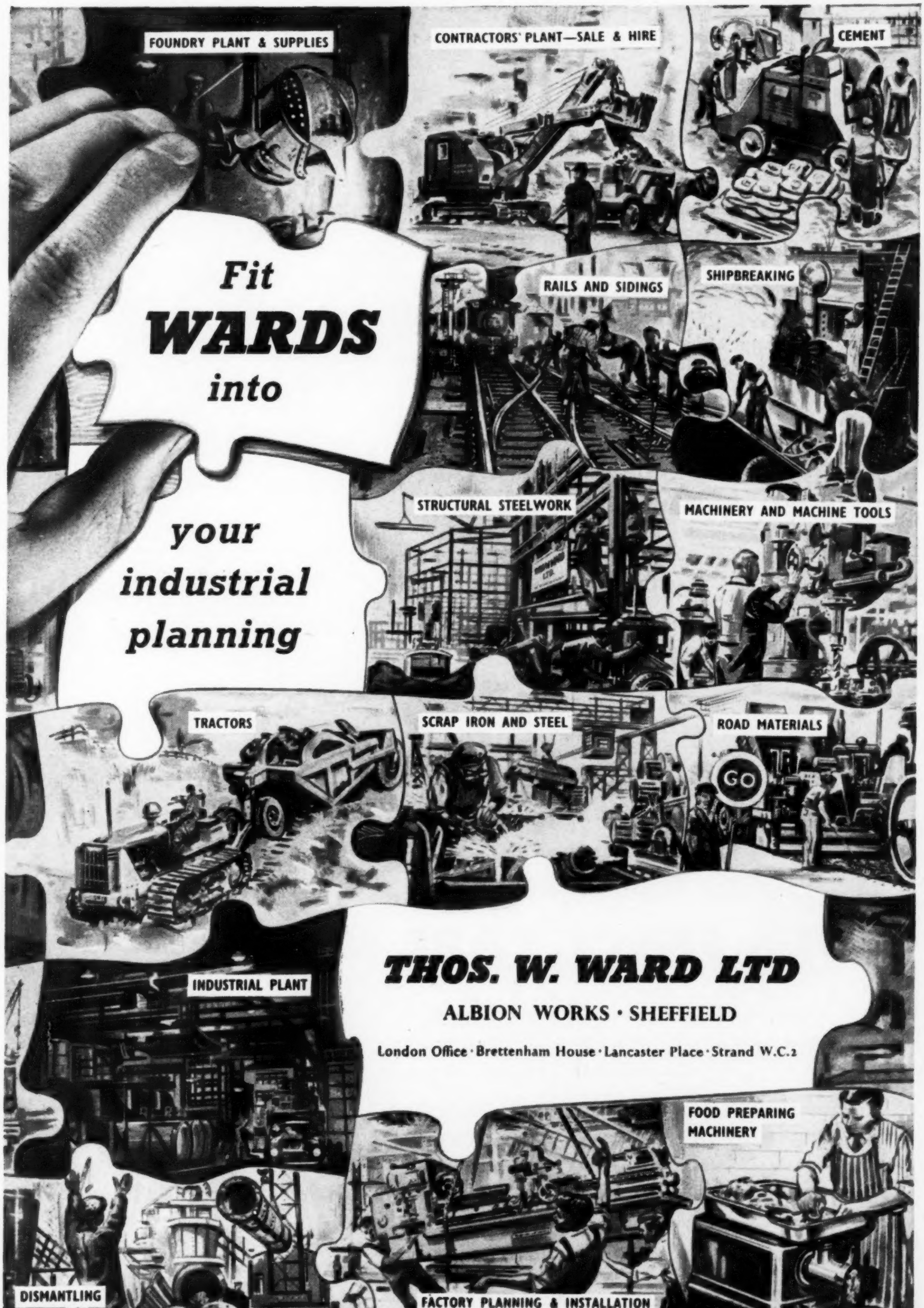
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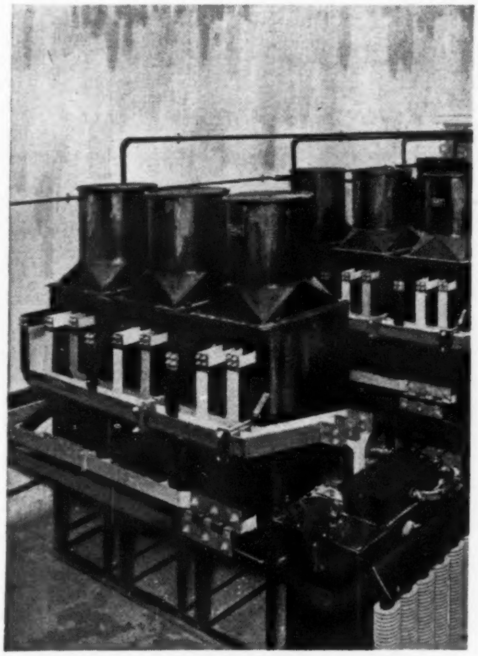

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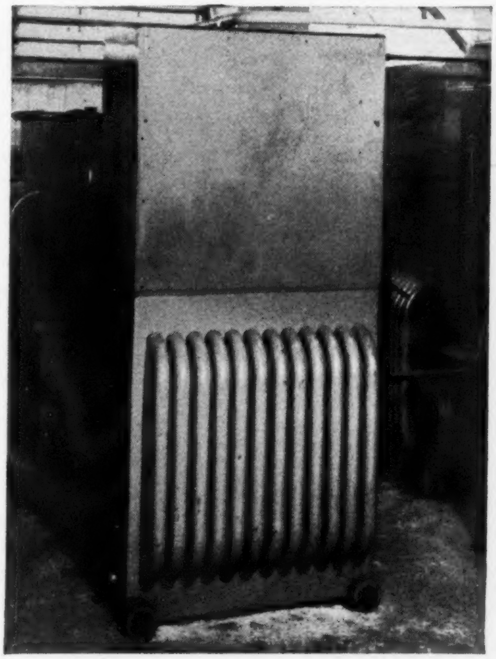

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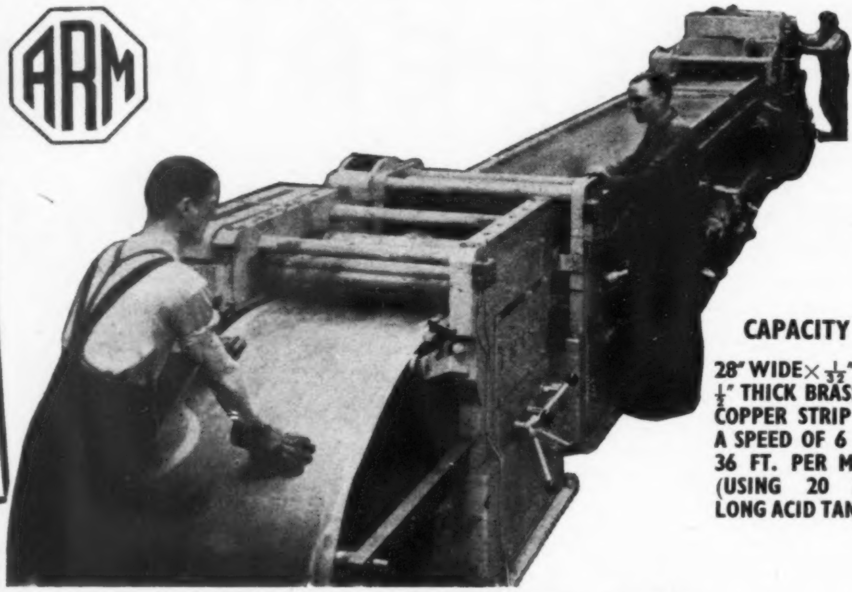

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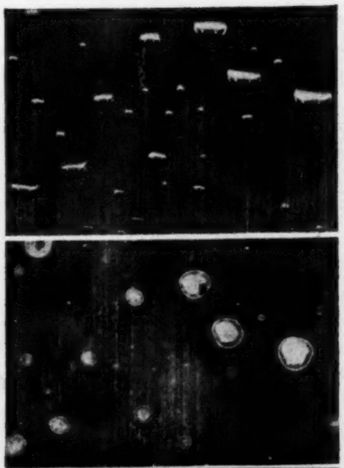

ABOVE *Without 'Trisec' Metal Drying Assistant, drops of water on a sheet of metal (top) leave stains on evaporation (bottom).*

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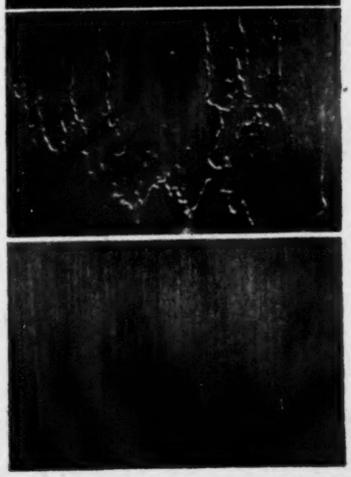

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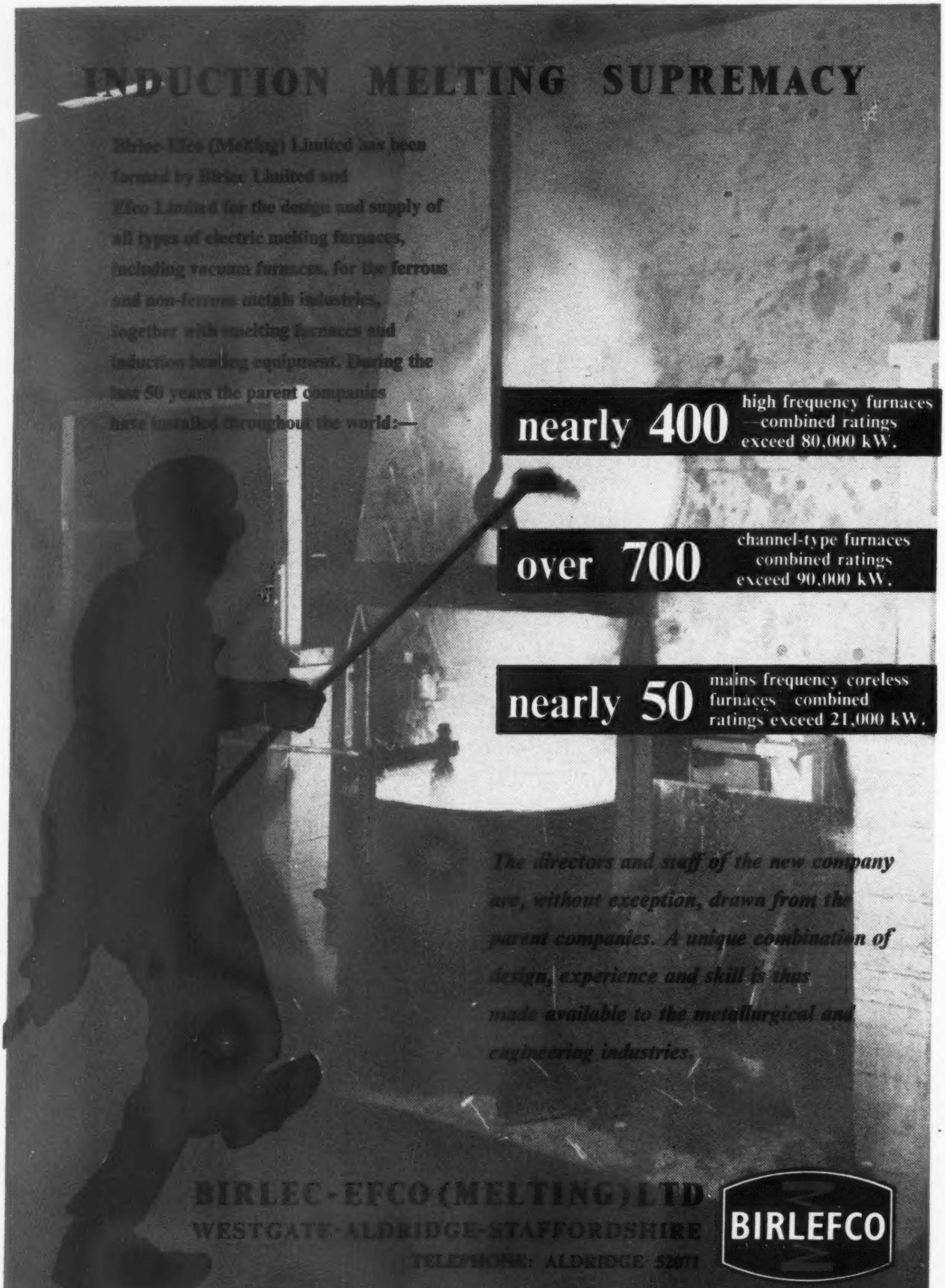
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METAL INDUSTRY

FOUNDED 1909

EDITOR: L. G. BERESFORD, B.Sc., F.I.M.

12 JUNE 1959 VOLUME 94 NUMBER 24

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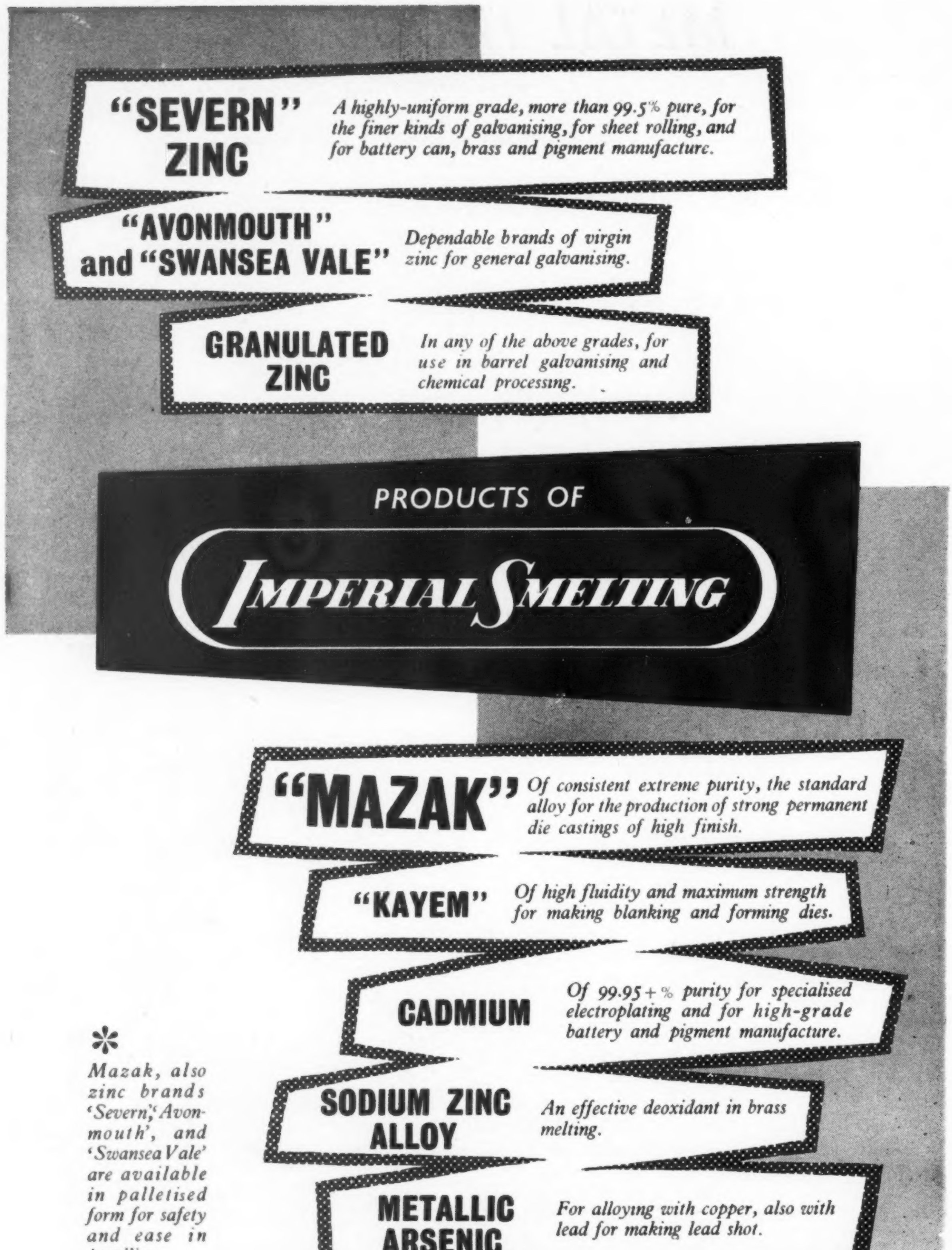
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METAL INDUSTRY

VOLUME 94 NUMBER 24 12 JUNE 1959

Non-Ferrous Metals in Yugoslavia

A COMPREHENSIVE overall picture of the Yugoslav non-ferrous metals industry is given in a report issued on the occasion of the Zagreb International Fair. Taking 1939 as having an index number of 100, production of non-ferrous metals stood in 1957 at 235. This was split up into indices of 186 for ore extraction and 400 for the processing industry. The seeming incompatibility of these two figures is explained by the fact that, whereas before the war Yugoslavia exported great quantities of her non-ferrous ores and processed only a relatively small amount, in the post-war years more and more plants have come into operation for the treatment of indigenous ores. Yugoslavia's reserves of non-ferrous ores figure high in European combined totals, the country possessing 25 per cent of Europe's copper reserves, 20 per cent of its lead, 24 per cent of its bauxite, 36 per cent of its antimony, 7½ per cent of its zinc, and 6 per cent of its mercury. Ores of silver, bismuth, gold, cadmium, manganese, chromium and tungsten are also to be found. The reserves of manganese, nickel, vanadium, titanium and molybdenum have not yet been established.

Production of metals from native ores is still well below the potential production estimated on the basis of ore reserves in hand. Thus in 1957, production as compared with potential production, in metric tons, was as follows: blister copper, 33,735 (70,000); electrolytic copper, 30,128 (42,000); refined lead, 78,504 (90,000); raw zinc, 16,481 (20,000); electrolytic zinc, 12,560 (18,000); antimony, 1,769 (2,000); mercury, 425 (600); and aluminium, 18,134 (280,000). Comparing these figures with those for 1939, all show a very considerable increase with the exception of blister copper, of which 41,643 metric tons was produced in 1939.

In 1957, the combined annual production capacities in metric tons of non-ferrous processing plants were: for rolled copper products 38,000, for rolled aluminium products 26,500, for rolled lead products 9,000, and for rolled zinc products 4,000. The progress made here is best shown by the fact that the production capacities in metric tons in 1939 were 4,159 for copper, 15 for aluminium, and nil for lead and zinc. Although exports of non-ferrous metals have dropped slightly recently from the 1956 figure, they still play a leading part in the country's economy. Thus, in 1957, 14 per cent of all Yugoslavia's exports consisted of non-ferrous metals; in the previous year the share had been one of 14·9 per cent. The total value of what the report terms "metallic ore processed products," including ferrous ores, was, in 1957, 46 per cent above the 1955 figure, while in the same period the value of ores and concentrates rose only by 6 per cent.

At present, all branches of the non-ferrous metals industry are being subjected to a concentrated expansion and modernization plan under a long-term industrial programme, with 1961 as its target year. Stress is on the increased production of blister copper, rolled copper and aluminium, while output of lead, zinc, mercury, antimony, bismuth and silver is also planned to rise. New processing plants are being built for all branches of the industry, and existing installations modernized and expanded. Targets for 1961 for the leading products, in metric tons, are as follows: blister copper, 40,000; rolled copper products, 30,500; aluminium ingots, 35,000; rolled aluminium products, 23,000; lead, 75,000; zinc, 32,500; and mercury, 530. After 1961, the planned respective outputs will be 55,000, 37,000, 100,000, 45,000, 85,000, 38,000, and 550 metric tons. In all of these branches except lead, 1961 figures are up by an average of about 50 per cent on 1956 figures. The output of lead in 1956 was, in fact, 75,759 metric tons.

Out of the MELTING POT

Better Than One

WITHOUT going into the details of the relative merits and demerits of electrolytic and hot-dip tin plating, it is still possible to appreciate the fact that, as in other somewhat similar situations, it has taken an invention to realize the benefit to be derived from the use of the two processes in combination. The resulting process involves the deposition of a thin electrolytic tin coating on the surface of the steel. This deposit is then heated so that it forms a tin-iron alloy coating, and the sheet or strip is then coated by the hot-dip process. The process is based on the discovery that the alloy coating formed when the electrolytic tin deposit is heated remains largely unaffected during the subsequent hot-dip coating operation. Thus, a way is provided of obtaining a hot-dip coated tinplate having an intermediate alloy layer of a thickness which can be controlled at the desired value by controlling the thickness of the electroplated tin coating. In this way the adhesion and solderability conferred by the presence of the alloy layer can be secured without the embrittlement and the unnecessary consumption of tin which result from the formation of alloy layers of excessive thickness due to lack of adequate control in the hot-dip coating process when used on its own. Another advantage of forming the alloy layer in advance by electrolytic tin plating and the heating of the steel sheet or strip, is that it enables the production, in the subsequent hot-dip process, of a coating having a thickness which, if desired, can be much less than the minimum thickness obtainable when hot-dip coating the material without the preliminary formation of an alloy coating.

No Strategy

WHETHER it is, in fact, endless or not, the frontier of science has certainly been extended to such an extent that those mounting the frontier posts have lost contact. From the military point of view this is an unforgivable blunder. From the scientific point of view the verdict is less definite, and, indeed, is still the subject of considerable discussion. The reason for this absence of a clear cut decision is, of course, that, unlike the military, who between the wars have ample time verbally to fight over the last or last but one and to draw all the necessary conclusions (whether they learn from them or not is another matter), the scientists are all the time so fully engaged in pushing forward, occupying new territory and setting up new posts, that they have little opportunity to discuss tactics, let alone overall strategy. It is somewhat surprising that in these days of specialization, specialists, consultants, and such like, so many of them self-appointed, in this, that, and everything else imaginable, somebody should not have come forward to fill this fairly obvious vacancy. The strategy of scientific progress certainly needs developing, and even its tactics would probably benefit from being elaborated beyond the elementary: "Send reinforcements, I am going to advance" to which they seem to amount at present. And even this demand for reinforcements—more scientists and more technically trained people—tends to be uncertain and subject to apparently unpredictable fluctuations. In principle, of course, this demand for reinforcements links up admirably with the thinness to which the forward line occupying the frontier has been stretched. Reinforcements in adequate numbers would certainly help to re-establish contact all along the frontier. There would still remain the problem of communications along this line, but that is another story. It will, perhaps, be pointed out that with no grand strategy and with only rudimentary tactics, the progress made by advancing science is all that can be desired, and far more than could have been expected. Even breakthroughs are sufficiently frequent to satisfy anybody. Without trying to dispute these facts, one might perhaps only point out in reply that the strategy referred to above would, among other things, also have to consider the situation behind the front line: the breakthrough of science not only into the unknown, but also into our daily life, which latter, for all that is realized, may also need some reinforcement.

Understanding

NON-SPECIALISTS—if there were any—sat to benefit in several ways from the masterly survey which Professor Petch recently presented to the Institute of Metals of the Papers and discussions at a conference, held earlier this year in America, on "Atomic Mechanisms of Fracture." There was, of course, first of all the benefit to be derived from the resulting improved acquaintance with the subject matter as such. The latter was covered by Professor Petch in four easy stages devoted, respectively, to ductile, brittle, fatigue and creep fracture. In future, i.e. at least for a year or so, the non-specialist will now be able to picture ductile fracture as a combination of the familiar external necking with fracture originating from fracture nuclei formed by the detachment of inclusions from the matrix and then growing as a result of a movement of the free surfaces of the metal under the effect of an internal necking type of deformation of the matrix. He will be able to picture, perhaps a little less distinctly, brittle or cleavage fracture being originated by a piling up—possibly a dynamic piling up—of dislocations, at a slip plane or other suitable locality, and their then being squeezed together or coalescing to form a crack, which then grows as a consequence of the stress concentration it produces. He will be able to continue to try and take an interest in the to-and-fro slip and the resulting surface extrusion and intrusion phenomena which are considered to be connected in some way or other with the initiation of fatigue fracture. Finally, he will be able to keep at the back of his mind an impression of creep fractures originating from fracture nuclei formed either where strains converge and obstruct one another, where grain boundary flow fails to be relieved by plastic deformation within the adjoining grains, or as a result of the migration, precipitation and coalescence of vacancies. As a more general benefit, the non-specialist should have been able to carry away with him the comforting thought that his failing to understand some atomic mechanisms of fracture need be no more than a reflection of the same failing on the part of the specialists. Indeed, the latter might examine the possibility of using lack of understanding on the part of non-specialists as a rough and ready indication of the need for further study on their part.

Skimmer

FORMING — CUPPING — DRAWING — FORGING — EXTRUSION — HARDENING

Explosive Fabrication

By H. VENSEL

BOTH conventional and "exotic" metals are being formed, forged, sheared, extruded, blanked, hardened, welded, compacted, and even machined—in most instances with surprisingly good results—by means of low and high explosives.

Low explosives or propellants are materials that burn as slow as one inch per second, and they have heretofore been regarded as one of the more practical sources of power for high-energy metalworking. High explosives do not necessarily produce more power than low explosives but their detonation rates (ranging to about 34,000 ft/sec) are in many cases making it possible to do much work in far less time with relatively inexpensive tooling.

The industrial potentialities of high explosives have long been ignored, mainly because such materials are known to be hazardous. However, experienced users now agree that they are not especially dangerous in the hands of properly-trained employees.

Although high explosives cannot be used on factory production lines like punch presses, in relatively large outdoor areas they can do many things that would otherwise be impracticable. For example, they have been used to make cup shapes more than 6 ft. in diameter and 3 ft deep from new titanium alloys that are almost impervious to elongation in a conventional hammer or press.

The usefulness of both low and high explosives is attributable in large part to their ability to cause hydrodynamic flow in metals. The nature of this flow has not yet been satisfactorily explained, yet its occurrence is so predictable that hydrodynamic flow equations can be used with extreme accuracy to predict the velocities needed to form metals whose flow properties are known.

Therefore, where the quality of explosive charges is adequately controlled, parts can be duplicated with such consistency that virtually none of the scrap losses due to conventional forming will be incurred.

It is further worth noting that high explosive forming can be done with a low capital investment, since it does not necessitate the use of either machine tools or costly tooling. This is important in view of the growing obsolescence of much available machinery.

Cast Kirksite, epoxy plastics, concrete, and even plaster of Paris are among the tooling materials that have been satisfactorily used to make short-term dies for high explosive forming. Air-hardening steel dies are generally specified for long production runs, but they are not costly in the usual sense because female dies alone can be used to form most parts. Male dies are generally non-essential because high explosive forces can serve their purpose.

Methods of high explosive forming are numerous, yet in most respects similar. In general, a charge is suspended a predetermined distance from a die-backed workpiece and then detonated. Retainers of various types may be used to increase the time during which resultant pressure is brought to bear on the workpiece, but provisions are usually made for the eventual escape of expanding gases—since energy savings due to the use of a closed die system would be greatly exceeded by the cost of building a system that could retain high explosive forces without damage.

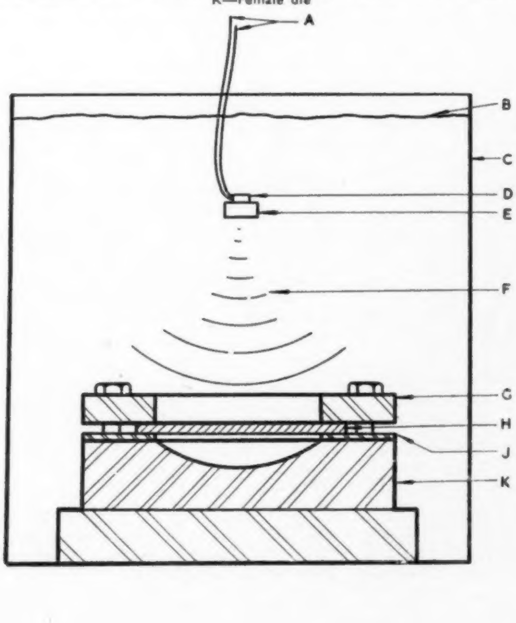
Air will transmit explosive forces, but where such a medium is used, tiny particles from a charge may become embedded in a workpiece. The latter phenomenon can be prevented, if necessary, by premasking a workpiece with a material such as paper. However, most manufacturers currently prefer to avoid the premasking process by using water as the transmitting medium.

Some organizations have found it practicable simply to immerse forming tools, workpieces, and charges in water —which is usually retained by a reinforced hole in the ground. Others have found it desirable to retain water above a workpiece in such a way that the space between the workpiece and its die can be evacuated prior to the detonation of an explosive charge.

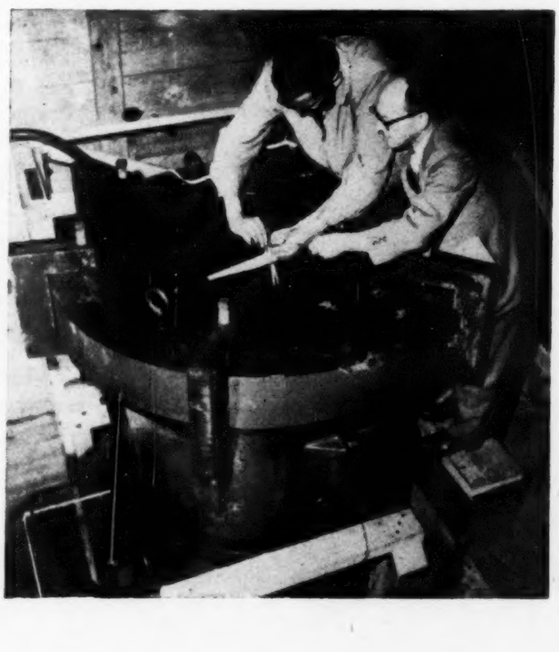
Regardless of which of the latter

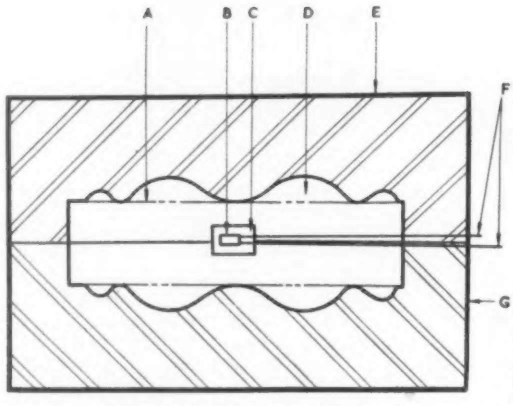
Arrangement of tools for high explosive cupping or drawing

A—Firing leads. B—Water level. C—Tank. D—Detonator. E—Explosive. F—Forming waves. G—Hold-down ring. H—Blank. J—Sealing ring. K—Female die



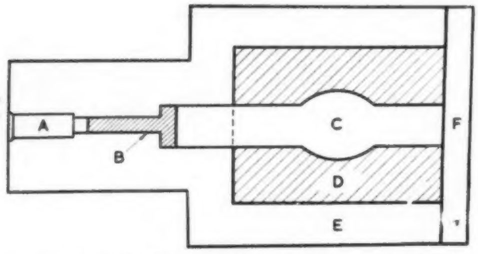
Explosive charge being lowered into steel waterhead for high explosive forming [Courtesy Boeing Aircraft Corp.





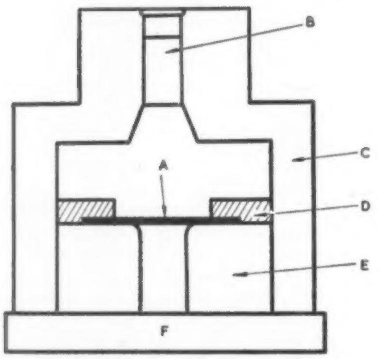
A—Preform. B—Squib. C—Powder. D—Die cavity. E—Top die half. F—Firing leads. G—Bottom die half

Left: Closed die system for low explosive bulge forming



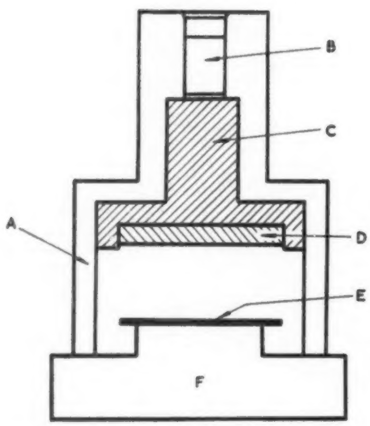
A—Cartridge. B—Piston. C—Hydraulic fluid. D—Forming die. E—Enclosing retainer. F—Cover plate

Right: Low explosive forming arrangement using blank cartridge to actuate a piston that in turn compresses a hydraulic fluid against the part to be formed



A—Blank. B—Cartridge. C—Enclosure. D—Draw ring. E—Die. F—Cover plate

Closed die system for low explosive drawing



A—Guide posts. B—Cartridge. C—Piston. D—Trapped rubber. E—Blank. F—Bolster

Explosive forming permits the use of greatly increased velocities with more or less conventional tools, as in this cartridge-assisted drop hammer

techniques is employed, users agree that parts formed with high explosive forces undergo such insignificant springback that it is generally practicable to produce deep draws with interchangeable tolerances. Consequently, several companies are currently using high explosives for the primary purpose of producing the final configurations in parts that have been preformed by other methods.

High explosives suitable for forming include such varied materials as nitroglycerine-base gel dynamite, TNT, ammonium nitrate-base dynamite, RDX, and PETN. Of these, RDX and PETN appear to have the advantage of a generous safety factor—since they are not generally detonatable in anything but carefully controlled circumstances.

The amount of explosive required to do a given forming job may range from less than one to more than 1,000 gm., depending on the size and properties of the workpiece.

Curiously enough, ductile materials like aluminium and copper are comparatively difficult to form with high explosives—mainly because it is hard to prepare charges small enough to produce desired elongation without causing damage. Extremely tough materials like stainless steels and titanium alloys, on the other hand, seem to lose their normal fracture tendencies to the point where they can sometimes be elongated about 75 per cent more than would be possible by conventional hammer forming.

Explosive forging, shearing, extrusion, and blanking techniques generally resemble standard processes in that energy is transmitted to workpieces via tooling. However, relatively inexpensive tooling can be utilized because no prolonged contact between dies and workpieces is necessary and because inertia minimizes the tendencies of the tools to become deformed in the process of forming.

For example, tungsten bars (preheated to 4,000°F.) have been extruded into wires about 5 ft. in length with normal tool steel dies and retainers.

The use of explosives for metal hardening purposes involves the use of heat and energy from relatively small charges of high explosives and has (among other things) made it possible to increase the hardness of extremely ductile or non-heat treatable metals like 99·9 per cent pure aluminium, titanium, magnesium, iron, copper, etc. In work with metals that might be hardened by other means, explosives have proved to be particularly valuable in that they can rapidly induce localized hardness in inaccessible areas.

Some distortion may occur during explosive hardening, but it is claimed that distortion can nearly always be held to a minimum if the right charges are properly employed.

Some progress in the field of explosive machining has been reported and a special linear velocity tool is being tested.

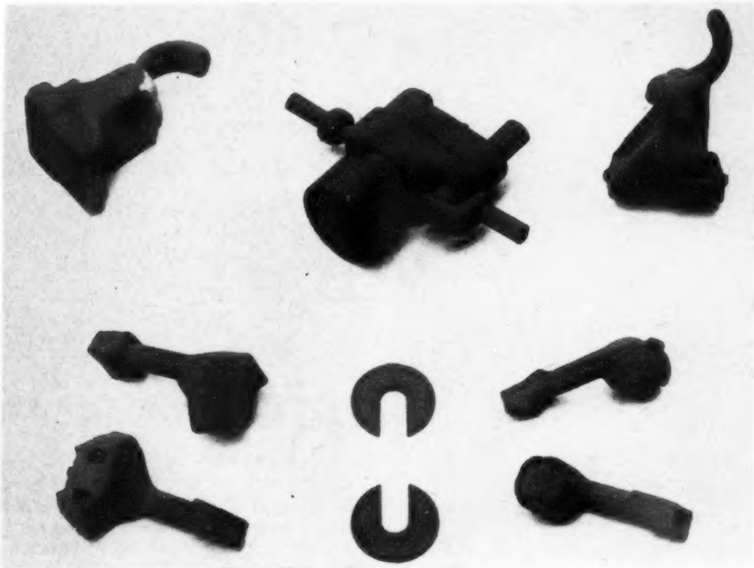
This tool is described as a 30-06 Mauser action gun with a 28 in. smooth bore barrel, stock, and a tool holder which screws on the end of the barrel to retain a $\frac{3}{8}$ in. square tool bit. Its purpose is to eject small workpieces from the barrel at speeds up to 180,000 surface ft/min.

Workpieces fired to date have been 2 in. long slugs of 4340 steel, conditions of which ranged from fully annealed to fully hardened; and, encouraging results have been obtained with 90° "V" tools, having both positive and negative rake angles, and with broad-nosed tools which had negative rake angles.

Definite cutting action was attained without cutter failures, although no chips could be found. Surface finishes of the cuts were as fine as 15 micro-inches, and tests indicated increased hardnesses ranging from 1 to 4 on the Rockwell C scale. Further, initial hardnesses of slugs apparently had little or no influence on either the cutting action or the longevity of tool bits.

Another potential use for high explosives has been experimentally investigated by the U.S. Naval Ordnance Test Station, China Lake, Calif. It involves the compacting of various metal and ceramic powders, and results indicate that such work can greatly increase the strength of sintered metal products by improving their density.

The main problem in explosive compacting is said to be a matter of retaining powders during the process. However, trouble in this connection can be avoided in two ways. One involves the retention of powders in closed dies, so that work can be accomplished by using explosive charges to power special double-acting compacting presses. The other consists of placing powders in a completely enclosed die cavity, applying an explosive coating to the die, and then detonating the coating.



A selection of typical cores produced on Steloy machines

Automatic Shell Core Making

IN certain conditions, core production can be the "slow-down" factor in the production of castings, and in any case, labour costs and bench space all tend to turn the attention of the foundryman towards a means of high speed core production. One of the most recent developments in this direction is the Steloy SA/1 automatic core blowing machine from which it is claimed 240 hollow cores/hr. can be produced with the machine working automatically with a double-impression corebox.

This machine is the latest development in the Steloy range, but the basic coremaking principle used is similar to that of its semi-automatic predecessors. Briefly, this comprises a sand container above which is mounted a table to carry the corebox. Precoated resin sand is used, and air is introduced below the volume of sand, forcing it up through the orifice in the table and into the corebox. After an investment period that can be adjusted to suit the requirements of the job, the air is exhausted, and the core is evacuated of air and free sand, leaving the hollow inverted shell within the corebox.

Still using this basic system the device that has now been developed provides either a fully automatic cycle or an auto-manual cycle.

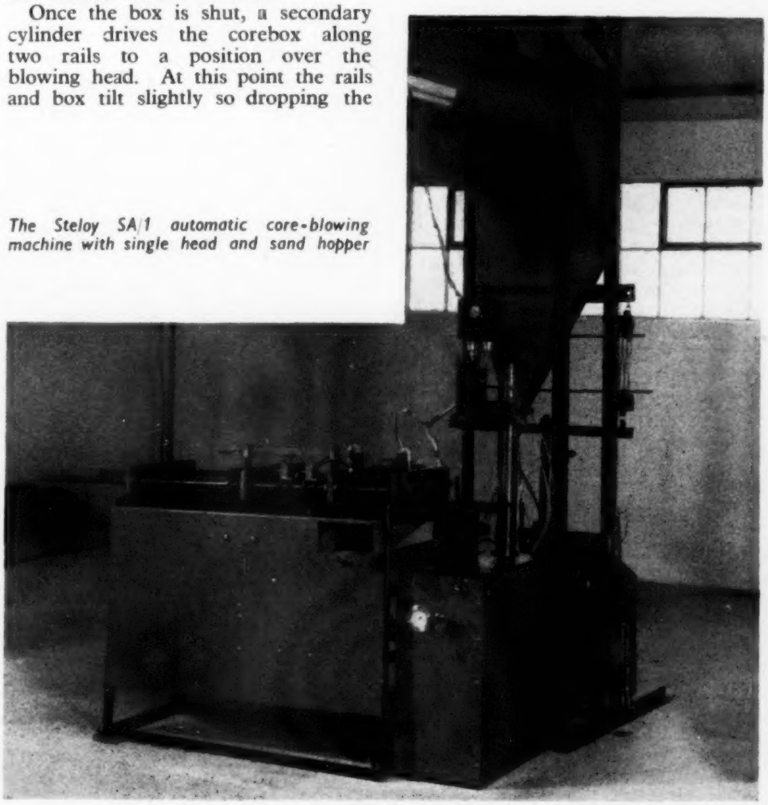
Auto-Manual Control

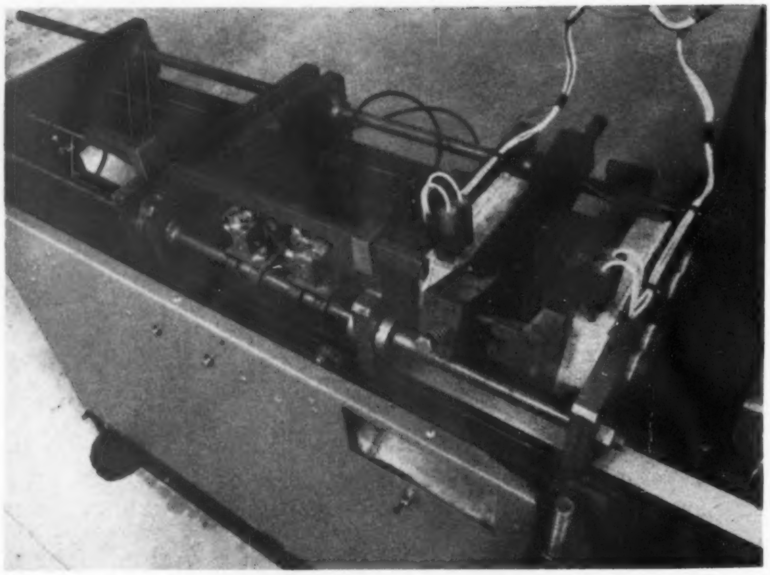
On auto-manual control a safety device is incorporated that prevents the operator from getting his fingers caught in the initial closing of the box. To achieve this, two buttons are located on the front of the unit, far enough apart to necessitate the use of both of the operator's hands. To close the box both buttons must be pressed simultaneously and the release of pressure from either, before the box is completely shut, will cause it to fly open again immediately.

Auto-manual operation is as follows: Both operating buttons must be pressed together, whereupon the corebox will be closed by a pneumatic cylinder. When the box is closed, the cycle becomes automatic and the operator can release the two buttons.

Once the box is shut, a secondary cylinder drives the corebox along two rails to a position over the blowing head. At this point the rails and box tilt slightly so dropping the box through 90° into accurate location on the blowing head. Metal to metal joints are used between box and head, and the object of tilting on to the head is to alleviate any tendency to wear the joints by abrasion. As the box locates on the head it is clamped vertically and the blower unit then performs the duty of blowing the core, investing and exhausting. When the blower unit has completed the operation, the vertical clamp flies off, the guide rails tilt the box off its seating and the secondary cylinder withdraws the box from over the blowing head. At this point a short curing time is allowed before the primary cylinder opens the box and

The Steloy SA/1 automatic core-blowing machine with single head and sand hopper





The corebox open, showing the guide rails, pneumatic cylinders and delivery chute

the ejector plate releases the cores, which then drop upon an inclined chute and are delivered to the side of the machine, where trays or conveyor belts can be arranged to receive them.

When the machine is switched to "fully automatic" operation, all these sequences take place on their own, and as a new patented automatic hopper feed can be supplied, the machine will then run indefinitely, making and ejecting consistent cores.

The coreboxes may be heated either by cast-in elements or by electric heater pads bolted to the back of the box.

The various sequences are individually timed and can be altered easily for different types of core. The blowing unit is so designed that a single sided model SA/1 machine can be converted into a double sided model DA/1 in a few minutes. Whereas the "Steloy" SA/1 machine described uses one box only, the "Steloy" DA/1 machine uses two boxes with a consequent increase in production.

Air supply at 80 - 100 lb/in^2 is required for the operation of the machine, but average blowing pressures are around 20-25 lb/in^2, a reducing valve being provided to reduce the pressure. Air line moisture does not affect the cores as all air is dried as it enters the machine.

Most of the better-known pre-coated resin sands can be used but certain "self-mixed" resin and sand mixtures will also give satisfactory results.

Metal Degreasing

IN metal degreasing, the value of trichloroethylene became apparent in the late 1920's. It is non-inflammable, has a convenient boiling point (86·7°C.), a low heating requirement, a dense vapour (4½ times heavier than air) and, above all, superlatively good grease-solvent powers. Moreover it can be purified for re-use by distillation.

In 1929, I.C.I., who already made this solvent, undertook the supply of degreasing plants. This was a vital stage in development. Trichloroethylene, though an excellent grease solvent, has anaesthetic properties. Single, overall control of plant design and solvent usage was, therefore, essential to ensure the process was safe for industry.

Metal degreasing by trichloroethylene involves immersing cold, greasy metal parts in hot trichloroethylene vapour. Solvent condenses on the metal and dissolves and washes away the grease. The essential point of this—the simple vapour process — is that degreasing occurs in freshly distilled solvent. Where swarf, polishing compound or other solid soil is present, it may be necessary first to immerse the parts in boiling solvent, or subject them to jetting with hot solvent, but the final treatment is almost invariably in vapour. After treatment, the parts are clean and dry, ready for further processing.

Some of the latest plant, designed for a wide variety of degreasing operations to suit components of widely divergent shapes and sizes, were on show recently at the Metal Degreasing Section, at Runcorn, of I.C.I. General Chemicals Division.

The first open-topped plant was introduced in 1931, and mechanized plants were later introduced. By using a conveyor system they eliminated manual handling, ensured better

Standardized double chain conveyor plant E-2LR for degreasing small work requiring rotation in boiling trichloroethylene

process control and reduced solvent usage. In the years that followed, an infinite variety of such plants was built. Conveyor systems used ranged from mono-rails, single and double chain conveyors, to mesh belts, electric and pneumatic lifts. Each plant was specially designed to suit the needs of a particular customer. Recently a standard mechanized plant has been introduced known as the Type E. It utilizes a double chain conveyor system and can be supplied in several forms, depending on the type of treatment required.

Safety and economy go hand in hand, and in 1930 a personal service was started. Fully trained technical service representatives started visiting potential and existing customers to give on-the-spot advice on the choice, siting, installation, start-up and routine operation and maintenance of I.C.I. plants. There are now twenty-three of these representatives, whose full-time occupation is this matter of safety, service and the solving of industry's problems by the provision of the most suitable degreasing process. They join with the Metal Degreasing Section headquarters staff of engineers and chemists in examining each new problem presented by a customer. Visits are regularly made to all solvent users, including those owning competitive degreasing plants. A detailed record is maintained at Runcorn of these plants and every one of the 20,000 I.C.I. plants so far made.

Apart from metal degreasing, newer uses have been developed for trichloroethylene.

The most recent development is "Trisec"—a new product for rapid drying. "Trisec" contains trichloroethylene and is used in a suitably modified degreasing plant for drying water-wet metal parts quickly and with complete freedom from staining. (See METAL INDUSTRY, p. 143, 20 February 1959.)

Readers' Digest

NIMONIC ALLOYS

"The Nimonic Alloys." *By W. Betteridge. Published by Edward Arnold (Publishers) Ltd., 41 Maddox Street, London, W.1. Pp. vii+332. Price 80s. 0d.*

LONG prior to there being any clear understanding of thermodynamics, heat engines existed. The steam turbine of Hero of Alexandria, of circa 150 B.C., is just one example. Later, when the significance of such a fundamental truth as that encompassed by the Carnot Cycle was appreciated, the engine designer could exploit it to but a limited extent. Theory clearly demanded that the working fluid of an engine should initially be at a very high temperature. On the other hand, metallic materials having the chemical, physical and mechanical properties to withstand this were not available and scarcely became so until nearly the close of the second World War.

Dr. W. Betteridge, the author of the work forming the subject of this review, has, with some specialist assistance from colleagues, produced a well arranged and well documented book dealing with the heat-resisting alloys of the genus "Nimonic." Of this there are at present, seven species: "DS," "75," "80," "80A," "90," "95" and "100." There can be no doubt, however, that the author and his associates have power to add to their number. Indeed since this work was written '105" has emerged and it may well have followers.

Few will require to be told, as the name indeed suggests, that the "Nimonics" are nickel alloys. They are this, however, to a varying degree. "DS" has only about 40 per cent of the element; "75" over 70 per cent; "80" and "80A" slightly less; "90," "95" and "100" are about half nickel but contain a considerable amount of cobalt, while "100," at present uniquely, has some 5 per cent of molybdenum. The whole group contains a substantial quantity of chromium. This is not, of course, unnatural for, during the last fifty years, it has developed from the heater element alloy, "Nichrome," originally 80 per cent nickel and 20 per cent chromium. This, initially two constituent materials, was primarily required to withstand high temperature oxidation. Its hot mechanical properties were not of paramount importance. Today, when the most exacting application of heat-resisting alloys is within the aircraft gas turbine, the "Nimonics" contain up to nine elements, each having its allotted function. This is particularly true of carbon, chromium, titanium and aluminium, whose combined influence in conjunction with appropriate heat-treatment, is to produce grain size and boundary precipitation productive of a very low rate of creep.

With civil aviation's, at present unsatisfied, demand for higher and yet higher speeds combined with increased thermal efficiency in the aircraft gas turbine, it is but natural that the author, on the physical side, should attach the greatest importance to the creep of the "Nimonic" alloys. With regard to this, the engine designer has to steer a Scylla-Charybdis course. On grounds of thermal efficiency, he requires the least possible clearance between turbine blade tips and the casing. On the other hand, the growth of the blades during the turbine's working life must not be such as to allow these two to touch. This is a metallurgical-engineering problem of the highest magnitude, in comparison with which Ulysses's task of steermanship appears to be one of lesser difficulty.

While devoting much attention and space to creep, Dr. Betteridge does not neglect what is of like importance, fatigue and, to some extent, deals with notch fatigue. With regard to the latter, he has, however been rather too economical. Nevertheless, in a little over 300 pages, he does describe with a large number of illustrations, including some first class photomicrographs, the characteristics, constitution, methods of chemical and physical analysis and of fabricating this group of heat-resisting alloys, to which he and others associated with him, have so long and vigorously given attention.

This book is indeed by specialists, so, to those requiring specialist knowledge of the alloys with which it deals, it can be confidently recommended. **P.L.T.**

Powder Metallurgy of Refractory Metals

AMONG the investigations reported in an article in *Metal Progress* is one in which crushed magnesium (−200 mesh) was heated at 500°C. in oxygen at ~ 1 mm. Hg to increase the oxygen content to ~5 per cent. The powder was extruded from a 1 in. dia. compact to 0·25 in. round rod at 400°C. at ~ 0·1 in/sec. The extruded rod was creep-tested under an axial load of 1,700 lb/in^2 at 350°C.; the rate was 2×10^{-7} in/hr. The incorporation of magnesium hydroxide with magnesium powder, crushing magnesium powder in hydrocarbon liquids and condensation of magnesium vapour in an argon stream, were also tried. Extrusions of the crushed magnesium disintegrated in air, but the condensed magnesium gave stable, exceptionally smooth rods. One company atomizes molten magnesium by a stream of kerosene or similar hydrocarbon, centrifuging the resulting powder, compacting and extruding.

Some work on beryllium compacts resulted in the production of material similar to S.A.P. in which grain growth at elevated temperatures was severely restricted by surface films, apparently of iron compounds picked up during grinding operations. Such "S.A.P.-type" beryllium might find application in fuel containers for high-temperature operation. In the hot compaction of beryllium tubes, the tubes were compacted at 800°C. by radial pressure (transmitted by molten lead in a thin-gauge steel tube) applied to a concentric layer of powder inside a heated Nimonic 80 die mould fitted with a tapered split sleeve.

Atomic Progress

Uranium Alloy Transformations

THREE important effects arise in uranium when it is irradiated. Anisotropic growth or wrinkling of fuel rods may occur; irradiation and thermal creep can lead to bowing of stacked fuel elements; and thirdly, fission gas diffusion is associated with swelling of the fuel at high irradiation temperatures. All these effects are structure sensitive to some extent. For example, grain size has a marked effect on wrinkling, the surface distortion being minimized by a fine random structure. On the other hand, creep resistance is improved by having a coarse grain structure. It is not surprising, therefore, that the measurement and control of grain size have been intensively examined and coupled with more basic studies of the transformation characteristics and kinetics of possible uranium alloy fuels. Heat-treatment also affects the form and distribution of some of the intermediate phases found in uranium alloys. Whilst the factors which control swelling do not yet appear to have been fully resolved, evidence is accumulating to indicate that such inclusions can have an important effect. Thus, whereas the grain size of transformed uranium has been the major feature examined in the past, it is likely that the effect of heat-treatment on second phase inclusions will receive increased attention in the future.

In natural uranium-fuel reactors, the amount of alloying additions which can be made are limited to a low level by neutron capture considerations. In a Geneva Conference Paper,[1] Jepson *et al* describe the transformation behaviour of some cast dilute alloys containing less than 1 atomic per cent total alloy addition. The need to relate this work to possible production requirements was a factor in choosing technical purity uranium, made by magnesium reduction of the tetrafluoride, as the basis for the alloys. Carbon was the main impurity in this material (about 700 p.p.m.), followed by iron (about 100 p.p.m.) and aluminium (about 40 p.p.m.).

The TTT curve for high purity uranium consists of a single loop. Typical curves for technical purity uranium consist of two loops, apparently due to the additional impurities. The smaller upper loop has a nose at 640°C. and extends down to 610°C. The nose of the lower loop is below 570°C. In the Paper by Jepson *et al* the changes due to alloying are described relative to the double loop TTT curve of technical purity uranium.

In pure uranium, alpha grains are nucleated in a beta matrix by a shear process involving the co-operative movement of lattice planes in such a way that an orientation relation is formed between the two sets of grains. These nuclei grow by the continuation of the shear process or by diffusion—at low temperatures only the shear process is expected to operate. Co-operative shear movements are hampered by the presence of foreign atoms, so that the shear mechanism can be expected to be affected by quite small additions. Diffusion rates will be virtually unaffected by the presence of low concentrations of foreign atoms, and transformation by diffusion may be expected to play an increasing part as the alloy content increases. Jepson and his co-workers identify the lower of the two loops in the TTT curve for technical purity uranium with the single loop of uranium. The upper loop is of the form known to correspond to a nucleation and diffusion process. Some confirmation of this is derived from the equiaxed type of grain structure produced by transformation at upper loop temperatures.

Effects of Alloying Additions

In the studies reported by these workers, all the alloying additions employed tended to depress the transformation temperature at a given cooling rate and also to reduce the rate of transformation. Chromium has a marked effect, while similar additions of molybdenum are largely ineffective. The following generalization is made, viz. those elements which show a marked change in solubility across a phase change such as iron, silicon and chromium, have a greater effect than those which are still partly soluble in the lower temperature phase, such as molybdenum and niobium.

Quenching Techniques

If the effects of the alloy additions are such that there is little interference with the shear mechanism, the shear loop will not be clearly separated from the diffusion loop. Under these conditions, equiaxed fine grain structures cannot be obtained below the upper nose because the shear process is contributing to the growth of the alpha grains. The authors conclude that, if there is a reasonable separation between the two loops of the TTT curve, isothermal transformation at temperatures just below the nose of the upper loop will produce equiaxed refinement. For beta-quenching to give adequate refinement, these workers state that some depression of the transformation temperature is essential. It appears that for beta quenching to give effective grain refinement the transformation should not start in less than 10 sec. at 400°C. On the other hand, the transformation should not be unduly delayed such that it occurs near ambient temperature, otherwise large grain-sizes may be obtained and quench cracking is common. Alloys of this latter type, e.g. uranium-2 at. per cent vanadium, sometimes exhibit grain refinement at the intermediate cooling rates encountered during chill casting.

In some alloys, grain refinement can be achieved by gamma quenching. In the case of uranium-aluminium alloys the results are more consistent than for beta-quenching, and it is only limited in practice by the tendency to cracking at high aluminium contents. The lattice is very strained after quenching, due to retention of the aluminium in solution, and an alpha-anneal of 15 hr. at 550°C. is required to complete the precipitation of UAl_2. The behaviour of uranium-vanadium alloys is more complicated. For example, a uranium-1 at. per cent vanadium alloy refines on gamma quenching, but not when beta quenched; while some other uranium-vanadium alloys are subject to beta retention on gamma quenching which leads to the development of acicular structures. Uranium-zirconium alloys give good refinement on both beta and gamma quenching. In the case of uranium-niobium and uranium-silicon alloys, gamma-quenching is associated with cracking. Uranium-chromium alloys show marked beta stabilization and crack even on beta quenching; these alloys are best refined by isothermal transformation.

In practice, beta quenching has the obvious advantage that it is faster than isothermal annealing. Jepson *et al* note that the latter is little affected by the presence of moderate amounts of impurities, and observe that it may find special application in the treatment of recycled or enriched uranium.

Mechanical Working

Fine grain structures may, of course, be achieved by the usual mechanical working processes. Unfortunately, these processes also induce various amounts of preferred orientation which, in general, must be eliminated if the bar is to be dimensionally stable under irradiation. Heat-treatments such as beta quenching can remove much of the preferred orientation, but this may be associated with slight grain coarsening compared with the structure in the "as-wrought" material.

Reference

1 M. D. Jepson, R. B. Kehoe, R. W. Nichols and G. F. Slattery; Geneva Conference Paper A/Conf. 15/P/27.

Finishing Supplement

Nickel Plating

NICKEL plating was the general subject for the first part of the second technical session of the Annual Conference of the Institute of Metal Finishing held earlier this year. Three Papers were presented and discussed and an abstract of each of them together with the discussion that followed their presentation, appear here. Contributions to the discussion were submitted in writing and read by the chairman.

The Properties of Bright Nickel Electrodeposits in Relation to the Period of Service of the Plating Bath

By J. EDWARDS

IT was shown in earlier investigations that certain of the properties of Super Gleamax and Efco Udylite No. 31 bright nickel deposits and solutions changed with increasing length of service of the plating bath. The ductility of the deposits tended to fall, the internal stress to increase and the bright plating range to contract. Evidence was presented which indicated that the content of organic impurity in the bath increased with time. The nature of the impurity was not known but it was considered that its presence was probably responsible for the observed deterioration in deposit properties.

During the operation of the pilot plants in which these tests were made, thick deposits were prepared at intervals for subsequent examination of their composition and microstructure.

In the current work, carbon, oxygen, hydrogen and nitrogen contents of bright nickel deposits from two proprietary solutions were determined by chemical analysis. The amount of organic material incorporated in the deposits tended to increase with increasing length of service of the plating bath. For both types of bright nickel there seemed to be a definite relationship between the ductility of the deposits and the amount of material (addition agents and impurities) included in them.

The results indicate that additions of anti-stress agent made periodically to one of the solutions, which tended to lower stress and raise ductility, reduced the total amount of organic material in the deposit. This requires confirmation, but could have important practical and theoretical implications.

DISCUSSION

T. E. Such and **R. Fyfe** (W. Canning and Co. Ltd.), in a written contribution read by **Mr. R. A. F. Hammond,** who was in the Chair, referred to the author's claim that the results given in Table I of the Paper proved that M730 additions lowered the total amount of organic material incorporated in a Super Gleamax deposit, and said that, while other evidence indicated that this might well be the case, they doubted whether this one experiment could be taken as confirmation of it. The compositions of the deposits before and after additions of M730 were too close to say with certainty that there had been a definite change. The author himself admitted that the reproducibility of the analytical determinations was not too good, the difference from the mean being sometimes as great as ± 50 per cent. Moreover, the carbon, hydrogen and oxygen contents were of the same order as those found in deposits from dull Watts type solutions, without any organic additions, as Brenner had described.

While the general conclusion arrived at in relation to the amount of carbon and oxygen absorption from the organics present in Super Gleamax solution was affected by the addition of stress reliever, it was very significant that at 40,000 amp-hrs immediately after such an addition there was a rapid rise to approximately 0·12 per cent carbon, as shown in Fig. 1 of the Paper. In view of these facts and of more recent work which might have been done, was the author still convinced that M730 did reduce the total amount of organic material incorporated in a Super Gleamax deposit?

D. E. Weimer (M. L. Alkan Ltd.) suggested that while no one would doubt the fact that organic impurities in a plating solution adversely affected the properties of the electrodeposited metal, the information given in the Paper was insufficient to establish that there was a quantitative relationship between the amount of organic matter absorbed and the change in physical properties of the deposit. Figs. 3 to 8 showed that for very small changes in the concentration of the organic matter in the electrodeposit vast changes occurred in the physical properties. It could be the case, therefore, that it was a question not so much of how much organic material was absorbed into a plating deposit, but what that organic matter was. It was known that many organic addition agents were decomposed under electrolysis, which gave the bad or poor physical properties obtained from an aged nickel solution. This was not surprising when regard was paid to the large number of organic materials which even in very small concentrations in a nickel solution deleteriously affected the nature of the nickel deposit.

Why had different concentrations of acetic and nitric acid mixtures been used for etching deposits obtained from the two different solutions.

J. Edwards, in reply, emphasized that the investigation had been a long-term job carried out under simulated production conditions in a pilot plant equipment. Each solution had been operated for about a year, and the main object had been to see what changes occurred in commercially-significant properties such as corrosion resistance; but, to get the most out of a fairly large effort, they had determined various characteristics of the deposit, and in the last part of the Paper, which he had now presented, he had given all the data, and it was necessary to see what could be made of them, bearing in mind that it was probably impossible to repeat the entire experiment. In the circumstances, therefore, one should not look for scientifically conclusive evidence, but rather for strong indications for future work, which he thought were given.

Table I was unconvincing as a demonstration that M730 reduced the total amount of organic material included in the deposit, but he felt that Fig. 1 provided rather good evidence of this. The large rise in carbon content to which Such and Fyfe referred at 40,000 amp-hrs. did not occur immediately after the addition of M730. There must, presumably, be some factor which brought about this increase, and that could perhaps explain the small decrease which occurred immediately after the addition was made, this factor opposing the effect of M730. The effect of a stress reducer was no doubt puzzling, and the work which he had recorded could not be regarded as establishing it. It required confirmation. In the work which they had done since they had not obtained confirmation, but they had not found any evidence to contradict it.

Similar considerations applied to Mr. Weimer's question about the relationship between mechanical properties and the amount of material included in the deposit. It was true that some substances had very much greater effects on ductility than others, even when present in small concentrations in the solution. The question was, whether these substances were specifically bad for ductility or much more strongly and rapidly absorbed and incorporated in the deposit.

The reason for using different etching solutions for the two deposits was that there was about a year between the examination of the two deposits. It was possible that the solutions given were the best for the two cases, but he did not make that claim.

Dr. S. Wernick (Consultant) said it was not clear from the Paper whether a rising increase in concentration of anti-stress agent was to be preferred to the presence of a constant but high concentration of anti-stress agent throughout. If the author could clear up that point it might afford a clue to the relative merits of the two processes, which was a matter of great interest to many people. It was not clear whether in the author's opinion a high

constant concentration of anti-stress agent was good or bad. In the last paragraph of the Paper such a condition almost seemed to be equated to the production of constant brittle deposits, and, as this was contrary to the general experience, further elaboration seemed to be required.

A. W. Wallbank (Ionic Plating Co. Ltd.) said that one of the main features of bright nickel plating which mattered to a production plater was how well it accepted chromium. It was well known that there was a variation between the different bright nickels in this respect. All of them could be plated, but some were more critical than others. The difference was most noticeable in barrel plating. There were considerable differences between various bright nickels when after plating in the nickel barrel they went on to a chromium plating barrel. He had checked the experience of his colleagues and competitors and found that they all seemed to have adopted dips between nickel and chromium at which they had arrived quite empirically. They knew that this effect was certainly associated with the organic matter occurring in the deposit, because it never happened with a barrel nickel straight from the sulphate solution without any addition agent. Could the author provide a clue as to what, in theory and practice, was the right dip to interpose to give the most receptive conditions for the chromium deposit?

J. Edwards said he did not know that he could answer Dr. Wernick's question of which was the more desirable, a steadily increasing concentration of anti-stress agent or a high constant concentration. It clearly depended on the conditions in the particular bath. Whether a stress agent was necessary or not depended on the addition agents which were being used. He did not now feel that it was differences in the way in which the stress-reducing agent was added which determined the differences in the structure of the deposits and therefore had some effect on the relative ductility; it was probably simply a function of the amount of material included in the deposit; but in practice it was necessary to consider a good many other properties of the solution as well as the ability to produce moderately ductile deposits.

The point raised by the second speaker was an interesting one, but not one on which it was possible to offer experimental evidence. It seemed likely that to some extent at least whether or not a bright nickel deposit would accept chromium would depend on the amount of the material in the deposit. If there was some kind of adsorbed layer on the top of the surface, some solution which would destroy the material, possibly an alkaline solution, or perhaps even a sulphate which would remove it could be used, but normally one would not expect very much extra material to be adsorbed on the surface, since in general an article would be removed from the bath with the current on and would have clinging to it the cathode layer, in which the concentration would be very much lower than in the bulk of the solution.

J. J. Dale (Electrodeposition Group, Defence Standards Laboratories) noted from the Paper that the sulphur had not been determined, and thought it would be most interesting to get figures for the sulphur along with the other elements which had been determined. No doubt there were good reasons why the sulphur had not been, and probably it was very difficult, but he would like to know why it had not been determined and what the author would have expected to find had he been able to determine it.

E. A. Ollard (Atlas Plating Works) said that his firm had tried out a number of commercial processes for bright barrel nickel plating before barrel chrome and had been able to divide them roughly into two categories: (i) those which gave a very nice, bright nickel deposit, but which they could not get to barrel chrome, and (ii) those that gave a less bright nickel deposit but which would barrel chrome. That bore out what Mr. Wallbank had said, that it was largely a matter of the amount of addition agent in the deposit. There could be a passive layer on the nickel which was extraordinarily difficult to get rid of. They had tried a number of dips but had never had much luck with them. They were running two at the moment, one for barrel chrome and one for bright nickel. With the addition agents which they had tried they had kept a tally of the amount and price of the addition per 1,000 amp-hrs.—not as recommended by the purveyors, but as actually found necessary—and had found an enormous variation in the price, of as much as 3/1 with different processes.

J. Edwards, in reply, confessed that there had been no good reason for not determining the sulphur in the deposits. The sulphur could in fact be determined quite readily by more than one method. If they had done the determination he could not guess what they would have found, but he thought that both deposits would contain sulphur. He welcomed Mr. Ollard's comments but had nothing to add to them.

J. J. Dale commented that the best results could not be expected if the addition agents were added in rather infrequent large dollops; it was much better to have a steady, regulated flow. That was well known, but very few people did it, because of the practical difficulties; drip feeds and valves tended to clog up and were unreliable. He would suggest, arising out of their experience with a chromium solution, the use of a device consisting of a wheel, driven slowly through reduction gearing, with small buckets and an ingenious gate device, so that the solution on being tipped out of the buckets went through a gate which was regulated by a hand wheel. In that way they had found it possible to control the specific gravity to the third decimal place.

The second point was that in their chromium bath they found a distinct lag in time between altering the solution composition and this showing itself in the deposit. This might be 20 to 30 hours. In a specific case it had taken 10 hours to reach equilibrium, sampling every hour under steady conditions. A similar thing happened with additions to a nickel solution. Had the author any data on the time taken by any of the additions to settle down and operate properly?

Rapid Quantitative Methods for the Determination of Brighteners, Levellers and Anti-Pitting Agents in Nickel Electroplating Baths

By K. SZMIDT, T. ZAK and Zb. KWIATKOWSKI

MODERN bright nickel plating baths contain a number of addition agents in the well-known Watts solution. It is easy to obtain from such baths bright nickel coatings free from internal stress, but difficult in practice to preserve the two qualities over a long period. The lack of rapid quantitative methods for the determination of addition agents is one reason for this. Such methods have in the past been slow in development because of (1) the low concentrations of these agents, (2) their great variety, and (3) the difficulty of separating the different addition agents, especially organic compounds. Classical analytical methods cannot be applied. Physicochemical methods such as colorimetry, surface-tension measurement, and especially polarography, are, however, becoming popular, and the rapid determination of addition agents in bright nickel plating baths has been achieved experimentally. Metal-ion additions can often be determined rapidly and accurately enough from the bath by direct polarography; the determination of cadmium is given as an example. Organic brighteners such as *p*-toluenesulphonamide and wetting agents such as sulphonated isopropylnaphthalene can be determined from their influence on the polarographic maximum of oxygen. If both are present the maximum bubble-pressure method for surface tension can be used to determine the wetting agent separately.

DISCUSSION

Dr. U. F. Marx (Wilmot Breeden Ltd.) commented on the fact that the authors did not mention the influence which breakdown products of the organic additives might be expected to have on their method for the determination of *p*-toluenesulphonamide and the wetting agent. It was known, he said, that the former broke down electrochemically, and it might be assumed that the latter did so too. The breakdown product of the brightener did not brighten the nickel deposit, but he would have thought that it lowered the oxygen maximum in a similar way to the starting material. It had been shown, moreover, that the breakdown was fairly rapid and could be detected after working the solution for only a few amp-hr/L. Had the authors investigated this aspect of the problem?

P. J. Ramsden (Electro-Chemical Engineering Co. Ltd.) believed the ability to analyse rapidly and reasonably accurately addition agents in bright nickel plating solutions was of paramount importance. Without good analytical

methods there was no hope of obtaining a consistently good performance from any solution, and this was particularly true of the bright nickel solution, which was the most highly developed and, therefore, often the most complex of all the plating solutions.

At the present time many proprietary bright nickel solutions could be fully analysed using methods developed by the supply house concerned. The methods for determining addition agents included colorimetric analysis, volumetric analysis, extraction by organic solvent followed by volumetric analysis, and titration of wetting agents. All these methods were relatively simple to use, and the worst of them gave results which were accurate enough for control purposes.

The use of the polarograph for determining addition agents was interesting, although it must be remembered that it was an expensive item of equipment. The main technical drawback to the use of this instrument would seem to be, as the authors had pointed out, the difficulty of interference from other addition agents or impurities. Had the authors considered the use of physical methods for effecting a preliminary separation? For example, activated carbon was very effective for removing by adsorption certain organic compounds, while it did not remove others. In the example given of *p*-toluenesulphonamide in the presence of the wetting agent, the latter could be removed by heating a portion of the solution with activated carbon and filtering. The filtrate could then be used to determine the *p*-toluenesulphonamide directly.

P. S. Clark (W. Canning and Co. Ltd.) referred to point 6 of the authors' general results: "The polarographic determination of brighteners and wetting agents can be effected only when no other organic or colloidal impurities are present." He asked the authors to amplify this statement and to say whether or not the method was therefore inapplicable to practical bright nickel plating solutions in which organic brighteners and metallic contamination were invariably present.

T. Zak replied to Dr. Marx that after the solution in question had been worked for 200 amp-hr/L it was replenished according to the results of analysis, after which the solution was in perfect order. In accordance with their technique, the solution after each period of 200 amp-hr/L was filtered through activated carbon, which eliminated *p*-toluenesulphonamide and its decomposition products. After filtration the solution was brought up to strength and worked again with very good results. With this method they had been getting good results on a production scale for the last eighteen months and the quality of the coating was satisfactory. Probably Dr. Marx referred to Fig. 3, which dealt with the fast depletion of Cd^{++} and not to organic substances, which obviously were being depleted much more slowly. There were no difficulties with the determination of Cd^{++}.

In reply to Mr. Clark, he said that metallic contamination did not cause any difficulties with their analytical method. On the question of organic substances, he would refer Mr. Clark to the answer already given to Dr. Marx. It could be stated that in the particular case of the authors' solution their method was applicable on a production scale, and they thought that it might be used satisfactorily for similar solutions, but the method would have to be proved for each particular bath.

Nickel Plating by Thermolysis of Nickel Carbonyl Vapour

By L. W. OWEN, B.Sc.

PROCESS variables include temperature, rate of flow of vapour, rate of flow of diluent gas and total pressure. These are controlled in operation of the process but it should be noted that total pressure is made up of partial pressure of nickel carbonyl vapour, carbon monoxide (the decomposition product) diluent gas and carrier gas if not also carbon monoxide. Total pressure is not a critical factor but there are practical advantages in plating at low pressure; i.e. below 100 mm., more especially below 3 mm. or at slightly above atmospheric pressures. The most critical variable is undoubtedly temperature which, if allowed to fall below a certain value, results in the development of a fissured surface and a brittle coating. The upper limit of temperature is not determined as regards the properties of the coating so much as by the development of excessive quantities of black soot-like deposits on the walls of the chamber. The rate of flow of vapour largely determines the rate of deposition but is not otherwise critical, although there are limitations.

Despite the apparent lack of critical variables, the process requires fairly careful control and some experience on the part of the operators if good results are to be obtained. Best coatings are comparable with best quality nickel coatings by electrodeposition, but brittle coatings of unsatisfactory appearance can result from plating at low temperatures or lack of control of temperature, sudden interruptions in vapour flow, or sudden changes in pressure are also to be avoided. Small amounts of oxygen from the air can result in unsatisfactory coatings, and with larger amounts, bright, smooth, highly stressed excessively brittle coatings are produced with hardnesses up to 800 D.P.N. Hardness of coatings centres around 200 D.P.N., but can be as low as 100 or as high as 350 D.P.N. Ductility usually follows hardness; i.e. the higher the hardness the lower the ductility, but there are notable exceptions such as embrittlement caused by fissure formation when plating at too low a temperature. Minor factors also appear to be responsible for some variation in properties which are not yet properly understood.

Porosity of the coating might be regarded as comparable with electrodeposited nickel, varying directly with thickness. Adhesion of coating to copper is extremely good without post deposition heat-treatment, with other metals a short period of heat-treatment results in a bond of high strength with a number of other metals.

DISCUSSION

Dr. J. W. Evans (The Chrome-Alloying Co. Ltd.), referring to the idea that the complication of the equipment would not commend it to conventional electroplaters, suggested that the author had not sufficiently emphasized the fact that this type of process conferred properties on the material which could not be achieved by any other conventional means, and in particular could give exceptionally high temperature oxidation resistance on the substrate metal, which could not possibly be achieved at the moment by conventional methods.

There was one disadvantage of carbonyl processes, namely, that the decomposition of the carbonyl yielded the metal and CO, which at moderately low temperatures was very unstable and was catalysed by the finely divided metal surface, giving CO_2 and carbon, one of which was carburizing and the other oxidizing. That had been observed with molybdenum and chromium carbonyls, where much higher temperatures were necessary to decompose them and one invariably had oxide and carbide formation.

It would be interesting to know the author's experience with molybdenum and nickel carbonyl in treating awkwardly-shaped objects.

L. W. Owen replied that Dr. Evans had made a very good point in referring to carbon formation and the side reaction whereby CO decomposed to give CO_2 and carbon, catalyzed by the nickel surface. It seemed that nickel deposited in the carbonyl was an even better catalyst than other forms of nickel. This gave rise to the formation of carbon, and that built up according to the temperature. At low temperatures, below 250°C., the amount of carbon was less than 0·1 per cent in the deposit, but as the temperature rose above this point the amount increased, and they had recorded as much as 0·3 per cent, but that was at above the normal temperatures at which deposition was carried out.

One particular advantage of nickel was that it did not appear to be embrittled by the carbon or carbide formed in it, at these concentrations at any rate, but with molybdenum that difficulty was one of the major obstacles to the process. The carbides pushed the hardness of the molybdenum coating up to very large figures, making it brittle and often unacceptable for some applications. Various attempts had been made to reduce the amount of carbon formed, the use of water vapour being one method.

With regard to objects of difficult shape, the equipment shown on the screen had been designed for solids of roughly equal dimensions. For special applications, such as long rods or where large quantities of small components had to be dealt with, the equipment had to be designed for the specific use.

J. I. Dale (Defence Standards Laboratories) asked whether any success had been achieved with this method with the difficult metals mentioned in the Paper,

such as molybdenum and tungsten, and whether there were any prospects of being able to make alloy deposits by the method. Could the author say anything about established applications with nickel carbonyl?

L. W. Owen said that molybdenum and tungsten had been plated from the carbonyl but the success had not been anything like so good as with nickel. The temperatures were high and it was necessary to be on the watch for carbon formation. The carbonyls themselves were not volatile. There were several difficulties not experienced with nickel; nevertheless, some of these metals were more interesting for certain applications and were not easy to deposit by other methods, and where specific applications arose it was possible successfully to apply coatings.

The deposition of alloys had been done only by one or two workers. The possibilities obviously existed. Considering nickel and chromium, for instance, chromium could be deposited from the carbonyl and it would seem reasonable to suppose that an alloy of those two metals could be deposited under suitably controlled conditions.

With regard to established applications for nickel plating, it was understood that the Americans had been applying this process on a commercial scale, and attempts to plate continuously wire and strip by this process were being made. One application was to coat paper by using a much lower temperature and sacrificing deposition efficiency. In that way it was possible to coat organic materials.

R. A. F. Hammond (A.R.D.E., Ministry of Supply) said he had been struck by the close similarity between the chemical properties of the nickel as described by Mr. Owen and those of electrodeposited nickel. Could Mr. Owen say how the crystal structure compared?

Another point about which it would be interesting to hear something, was the method of cleaning. His method of plating imposed a distinct limitation on the operator in cleaning the basis metal, and it would be useful to know the type of cleaning procedure employed and also the degree of adhesion on metals other than copper.

Vitreous Enamel on Aluminium

VITREOUS enamel as a finish can now be produced on aluminium, and a recent example of its decorative use was described on page 314 of METAL INDUSTRY, 17 April, 1959, where "Judgelite" panels were used in the balconies of a block of flats. It provides a hardwearing and attractive surface and can be produced to users' specified colours or to any selected from a standard range of 150 graduations throughout the spectrum, and varying from full gloss to matte as desired. The colours are light-fast and very suitable for both internal and external use.

Judgelite, a product of Ernest Stevens Limited, Aluminium Division, Cradley Heath, Staffordshire, has a finish which is achieved by the application of an inorganic coating on a suitably prepared aluminium surface, after which it is fused to the base metal under strict temperature control conditions to ensure uniformity of adhesion, a hardwearing surface and uniformity of colour. It has to be emphasized that the film thus deposited and secured to the metal is not a paint, but is in every sense a vitreous enamelled finish possessing superior properties.

In sheet, commercially pure aluminium or 1¼ per cent manganese alloys lend themselves well, but other alloys can be enamelled successfully by process modification. Formed sheets can be similarly treated.

Successful finishes can be achieved on a number of extrusion alloys, including certain heat-treatable types, and alternatives could be suggested on consultation if necessary.

In castings, L.M.6 and L.M.18 alloys are very suitable, but good results are available on other gravity die and sand castings.

The plant upon which Judgelite is produced comprises basically, chemical pre-treatment tanks, spray booths, and a 250 kW electric furnace of the resistance type.

Primarily, pre-treatment is carried out in caustic soda and nitric acid with intermediate washings, but can be modified to suit specific requirements.

Due to the nature of the work called for in this process, the sheets are treated in batch fashion by means of overhead transfer conveyor, culminating in a final water rinse when the oxide film has been built up to the prefiring stage in which the sheet to be enamelled is passed into the furnace for a predetermined period to complete the build up of the oxide film.

Batch-type furnace for firing vitreous enamel on aluminium

The enamel is sprayed manually or automatically on to the panels, dependent upon the form which they take, and they are subsequently re-introduced into the furnace along a driven roller table at predetermined speeds of travel appropriate to the nature of the work. The work is timed through the furnace at closely controlled temperature throughout in order to achieve the requisite bond strength as well as to maintain uniformity of colour. Fusing of the enamel to the aluminium is achieved at approximately 540°C.

The furnace itself is 20 ft. long by 4 ft. 6 in. in width, and fans are positioned in the roof to assist in maintaining temperature uniformity throughout. The work is laid flat in its travel through the furnace, but by suitable jigging arrangements it is possible to achieve a perfect finish on the back and front. Again, by the use of firing jigs, the 4 ft. 6 in. width of the furnace can be exceeded and up to 5 ft. width can thus be accommodated. This type of furnace construction permits of continuous feed of long sheets through the furnace, so that sheet length is not limited to the furnace length of 20 ft.

Fundamentals in the process are clean metal, free of inclusions and with a good mill finish, clean chemical solutions, and a clean, dust-free environment.

Fatigue Mechanisms

A SYMPOSIUM on the basic mechanisms of fatigue has recently been published by the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa. The Papers contained in it clarify some of the mechanisms of failure, such as dislocations, internal friction, crystalline and structural changes, and surface disintegrations. Various areas of observational levels are touched upon in discussing the mechanisms of fatigue. The Papers also help to emphasize the statistical nature of the material behaviour under cyclic loadings. The book is available from the Society, price \$3·75.

Industrial News

Home and Overseas

Atmospheric Pollution

Problems relating to atmospheric pollution have been tackled by the Yorkshire firm of **W. C. Holmes and Company Ltd.,** who have introduced the Holmes Schneible "SW" cupola collector, designed especially for the control of cupola emissions and to reduce atmospheric pollution. Among the particular features of this new collector are the following:—recirculation and re-use of water; no spray nozzles to clog; controlled water treatment; no fans, motors, or moving parts; centralized waste disposal; high temperature warning and control device, and patented adjustment of collector elements.

A useful brochure is being circulated by the company giving full details of the principle of operation of this unit, together with diagrams and photographs.

Welding Technology

A series of courses has been arranged by the **Institute of Welding** at the School of Welding Technology, commencing this month. Details of the courses are as follows: Brazing technology and design, from June 8 to 12; Welded design and construction in general and mechanical engineering, from June 22 to 26.

Giant Spray Booths

Two gas heated, paint spray and drying booths at the Tyburn Road Works of Birmingham City Transport Department are each big enough to accommodate a double-decker omnibus 30 ft. long, 8 ft. wide and 14½ ft. high.

The booths are of the water wash down draught type, each being 36 ft. long, 16 ft. wide and 18 ft. high. The entrance to each can be closed with power-operated roller shutter doors. Each booth is equipped with a moving gantry which rises 11 ft. above ground level around the vehicle to be painted. After a bus has been driven into a booth and sprayed, the roller shutter door is closed and gas-heated air is blown into the booth to dry the paint.

The air intake is through a louvred ducting in the outside wall of the paint shop, and this duct is coupled to an air filter unit. To heat air taken into the booth, an auxiliary hot air fan draws air from the shop through a direct fired gas heater into a mixing chamber in each booth. The gas-heated combustion chamber is fabricated from mild steel plate and lined with refractory brickwork. The burner is of luminous pattern and has a thermostatic control system. A fan failure protection switch automatically turns off the gas when the fan ceases to operate.

The gantry can be operated only from inside a booth. An interlock prevents the gantry rising if the gantry safety gates or roller shutters are not closed. Another interlock prevents the roller shutters operating if the gantry is not at ground level.

Moulding Machine Order

An order has been placed by Federated Foundries with **Baker Perkins Ltd.** for the supply of a Taccone diaphragm moulding machine. This machine, which will cost £27,000, will be capable of squeezing simultaneously two moulding boxes, 84 in. by 36 in. by 12 in. deep. The squeeze time for one complete mould will be 1·5 sec. It is believed that this machine will be the largest sand-moulding machine in the world.

The Taccone machine, which was demonstrated for the first time at the recently - held Foundry Exhibition in Birmingham, is suitable for high production or jobbing foundries, and makes really automatic moulding available. The production of the machine depends entirely on the speed of the handling equipment provided. It makes moulds which, the firm states, are consistently hard throughout.

A New Agency

It has been announced that **Flexible Drives (Gilmans) Ltd.,** of Smethwick, Staffs., have recently been appointed sole distributing agents for "Tyrolit" profile grinding wheels and shapes and "Tyrolit" secur cutting-off discs in the United Kingdom, India, Australia, New Zealand, Eire, and all Colonies of the British Commonwealth.

International Film Congress

News from the Scientific Film Association is to the effect that **H.R.H. the Prince Philip, Duke of Edinburgh,** has graciously consented to become Patron of the 13th Congress of the International Scientific Film Association. This Congress will be held in London and Oxford from September 23 next to October 2, and will also include a festival of popular science films, open to the public and presenting top documentaries from all over the world.

Ceramic Coatings

Following the introduction of their new product "Unikote" (ceramic coatings for metals and other materials), the United Insulator Division of the **Telegraph Condenser Company Ltd.** has now provided its first interim bulletin, which contains a great deal of essential technical detail which has been collated for this purpose.

Copies of this bulletin may be obtained free of charge to those interested.

Electric Furnaces

It is learned from **Wild-Barfield Electric Furnaces Ltd.** that they have received an order from the Mond Nickel Company Ltd. for a Wild-Barfield NRC induction heated vacuum melting furnace having a capacity of 112 lb. of nickel-based alloys. The furnace, which is to be used for the production of experimental alloys, will be powered by a B.T.H. 125 kW 3 kc/s vertical spindle type generator. The pumping system will comprise a 12 in. diameter booster diffusion pump in parallel with a 16 in. diameter high vacuum diffusion pump backed by a Roots type mechanical booster and a rotary gas ballast pump. A holding pump will be provided to enable either, or both, pumps to be held, or used on the tank.

Vacuum locks will be fitted, through which the furnace can be charged without opening the vacuum chamber. Provision will be made for mould locks to be added subsequently, to enable moulds to be transferred into the furnace quickly from a preheating oven.

All furnace power controls will be incorporated in a semi-automatic control panel on the melter's platform. Additionally, there will be a vacuum control panel with vacuum sequencing switches and gauges, and an illustrated diagram indicating the open or shut position of the vacuum valves, all of which are air-operated.

Reactor School Courses

Eighteen standard or full courses have to date been held at the **Harwell Reactor School,** and Standard Course No. 19 will start on August 31 and continue until December 18, 1959. Altogether, 951 students from 32 different countries have so far attended these courses, which began in September 1954 and are designed to train engineers in the techniques of reactor construction and operation, particularly in connection with nuclear power stations.

Half the places at each course are allocated to overseas students, and a fee of £250, exclusive of accommodation, is charged.

A special course for senior technical executives will be held from September 21 to October 1, 1959. This is the ninth course of this kind, and the fee is fifty guineas, exclusive of accommodation. Application forms and details of both courses can be obtained from: The Principal, Reactor School, A.E.R.E., Harwell, Didcot, Berks.

Aluminium Output

Recent news from Pittsburg is to the effect that the Aluminum Company of America has stepped up its output by an additional point, bringing it to 83 per cent of capacity, by reactivating idle facilities at its Tennessee works. In response to rising demand for aluminium, the company in recent weeks reactivated other idle potlines at its Point Comfort (Texas) and Vancouver (Washington) smelters.

Pipe, Valves and Fittings

It is learned from the Board of Trade that the British Consulate-General at Cleveland, U.S.A., has been approached by the M. J. Kelley Company, 17006 Kinsman Road, Shaker Heights 20, Ohio, who are interested in obtaining United Kingdom sources of supply of pipe, valves and fittings, in copper, steel, cast iron, aluminium and stainless steel. The firm wishes to purchase in sizeable quantities for stocking at their warehouse. Interested British firms are advised to contact by air mail, Mr. Richard J. Kelley, executive vice-president of the company. Quotations should show both f.o.b. and c.i.f. Cleveland prices in U.S. dollars.

Refining Copper

An interesting 16 mm. sound colour film, "Refining Copper from the Sudbury Nickel Ores" was given its preview in London last week by **The Mond Nickel Company Ltd.** In previous films, the International Nickel Company has presented the story of the vast and intricate processes involved in mining, milling and smelting, and refining of nickel. Now the

story of refining copper is added to this educational series.

The story of copper refining is attractively told, and the photography is excellent. The job of refining and producing high purity copper from the raw material received from the smelter is presented to the viewer with a clarity not always to be found in industrial films. This latest production in the series should undoubtedly be seen by technical societies and schools. The film runs for 39 minutes and can be freely available to industry on application to the sponsoring company.

French Aluminium Market

Demand for aluminium on the French domestic market has recently picked up considerably, so that deliveries to consumers in April were close to the record level of December 1957, French metal quarters report. The revival of the home market, if continued in the near future, may upset the French export programme for unprocessed aluminium, the quarters said. Last year the weak home demand led the French aluminium sales organization Aluminium Français to secure contracts abroad, and exports thus soared from 21,000 tons in 1957 to 56,000 tons. There were heavy sales to Mainland China and the U.S., in addition to the traditional Belgian market. Belgium received 18,000 tons in 1958, China 15,000 tons, and the U.S. 13,000 tons.

The deliveries to the home market, on the contrary, fell from 150,000 tons to 139,600 tons. But since January 1959 a considerable recovery of domestic purchases has been noted.

Although the Cameroons aluminium plant, which reached full capacity in July 1958—45,000 tons a year—now contributes to the domestic production, it is feared that the overall production would not meet both domestic and export demand. The situation is expected to improve in 1960, when the first units of two new plants in south-western France will start industrial production. These plants are scheduled to supply, when completed, a total of 80,000 tons of raw aluminium.

Trade with Japan

We are informed that **Electro-Chemical Engineering Company Ltd.**, a subsidiary of Efco Ltd., have received an order from Japan to supply an electro-metallurgical plant, the contract price being more than £300,000.

Aluminium Exhibits

An exhibition is being held from Monday next (June 15) until Saturday (June 20) in the Old Horticultural Hall, Vincent Square, London, S.W. The exhibition is sponsored by **The British Aluminium Company Ltd.,** and the main product to be shown is the new Rigidal Seamwall cladding. This consists of 12 in. wide panels up to 30 ft. high with a bold profile to give added interest to large scale industrial buildings.

There will be continuous demonstrations (10 a.m. to 8 p.m.) of erection methods, and a completed wall 90 ft. wide and 30 ft. high. There will also be detailed displays showing fixings to different types of wall and sheeting rail, the use of insulating linings, the treatment of door and window openings, and sample panels showing the range of surface finishes.

Rigidal corrugated sheeting in the standard profiles and finishes, and in lengths up to 35 ft., will also be shown. Admission is by ticket—or professional card.

New Factory and Offices

A larger factory, including an office block, has been acquired by **Causeway Reinforcements Ltd.,** a member of the Amber Group of Companies. This move has been made necessary by the expansion of trade in the special field in which the company operates.

The range of goods now produced by the company includes surface armouring for refractory linings, industrial linings, floors, roads, etc. Technical development and research facilities are available to meet special requirements. The new address is Five Ash Works, Dover Road East, Northfleet, Kent.

Sir John Cass College

The prospectus for the session 1959-60 of the Sir John Cass College, London, is now available and contains full details of the wide range of courses which are offered. The Department of Metallurgy provide full-time and part-time courses for the London University degrees of B.Sc., also for the Licentiateship and Associateship examinations for the Institution of Metallurgists.

Part-time day and evening courses are available in all ten subjects of the Institute's syllabus, practical instruction being given where necessary. A limited amount of laboratory space is available for postgraduate research both in the daytime and on certain evenings. The Department is particularly well-equipped for research work in the fields of physical metallurgy, melting and casting (including foundry work) and in the applications of radioactive tracer techniques to problems in the metallurgical and allied fields.

Applications for any courses and copies of the prospectus should be made to the Secretary of the College at Jewry Street, Aldgate, London, E.C.3.

U.K. Metal Stocks

Stocks of refined tin in London metal exchange warehouses at the end of last week rose 112 to 7,776 tons, comprising London 4,860, Liverpool 2,151 and Hull 765 tons.

Copper stocks rose 414 to 13,312 tons and were distributed as follows: London 2,547, Liverpool 5.967, Birmingham 973, Manchester 3,800 and Hull 25 tons.

India Exports Bauxite

India shipped 5,000 tons of bauxite to Japan in the 3rd week of May. Negotiations for further shipments of bauxite from India are in progress between private sectors in Japan and India. The Prakash mining corporation of Bombay which is engaged in the export of bauxite to foreign countries said that during the last two years, India exported 30,000 tons of bauxite, mostly to Australia, continental countries and Formosa.

Aluminium in Norway

Aluminium is probably Norway's fastest expanding production. According to "Norway Exports," output was 30,000 tons annually pre-war, 120,000 tons in 1958. Capacity would be 175,000 tons in 1960 and over 200,000 tons by 1965. Most was exported, and, next to Canada, Norway was already the biggest exporter of aluminium ingots in the world. One Norwegian company was investing £50 million in expanding aluminium production in the next few years. To produce 1 ton of aluminium took 20,000 units of electricity, and cheap electricity made aluminium production in Norway highly competitive.

Smelting in Chile

Since January 1952 when it started operations until the present day the Paipote Smelter, operated by the Empresa Nacional de Fundiciones, had produced 109,115 tons of blister copper plus 4,578,000 grammes of gold and 44,470 kilograms of silver, 982,365 tons of concentrates, ores and smeltings, produced by small and average size Chilean mines, were treated.

The Ministry of Economy announced that this production represented an approximate revenue in foreign currencies of 19,000,000 dollars over and above what the revenue would have been from the export of bulk concentrates and ores. This additional revenue was due to the saving on freight to foreign countries, and the cost of smelting the ores abroad which had to be paid for in dollars. The figures did not include additional income derived from the recovery and sale of the gold and silver.

The whole of the above mentioned output was exported through the port of Caldera to Hamburg for transformation into electrolytic copper and the separation of precious metals.

Australian Tariffs

The Australian Minister for Trade has referred to the Tariff Board for enquiry and report the question whether the existing Most-Favoured Nation rates of duty on some 250 tariff items should be reduced to the minima permissible under the United Kingdom-Australia Trade Agreement, the British Preferential rates remaining unchanged.

The Trade Agreement entitles the United Kingdom to minimum preference margins of 7½ per cent or 10 per cent, according to the level of the British Preferental rates. For the tariff items covered by the present reference, United Kingdom preference margins exceed these minima, and the Australian authorities believe that the Most-Favoured-Nation duties may be higher than required to give reasonable protection to Australian industry.

The items concerned include a wide range of engineering goods and certain consumer goods. Reductions were made in the Most-Favoured-Nation rates of duty on over 800 items in the Australian Tariff in 1957, but no reference was then made to the Tariff Board.

U.S. Tin Statistics

The average daily rate of tin consumption in the United States remained unchanged in March, but due to the longer month the total was 725 long tons more than February, according to the Bureau of Mines. Tin used in March, the highest since April 1957, totalled 7,510 long tons and comprised 4,700 of primary pig tin and 2,810 of secondary and imported tin-base alloys. February consumption of tin was 6,785 long tons, 4,245 primary and 2,540 secondary and imported tin-base alloys.

Tin consumption during the first quarter of 1959 was 18 per cent more

than the corresponding period of 1958 (primary increased 1,885 long tons and secondary 1,345). Compared with the fourth quarter of 1958, however, the total used increased 13 per cent (primary was 960 tons more and secondary 1,490 tons). During the first quarter of 1959, tin used for tinplate was 16 per cent more than the same period of 1958, and the final quarter of 1958.

In March, brass mills used 150 long tons of tin (85 of primary pig tin and 65 secondary pig tin and scrap). February consumption was 125 tons, 75 primary and 50 secondary. Brass mills' stocks of pig tin increased 45 tons and totalled 135 tons at the end of March.

Total United States tin stocks decreased from 36,500 long tons March 1 to 36,300 tons on March 31. Industrial stocks of tin in the United States decreased 670 tons to 21,755 during the same period. Tin metal afloat to the United States was 2,815 tons on March 31, an increase of 195 tons.

Non-Ferrous Club

Speaking at the monthly luncheon of the **Non-Ferrous Club,** held at the Queen's Hotel, Birmingham, on Wednesday of last week, Mr. Jack Mould, chairman of the Birmingham Federation of Boys' Clubs, suggested that a boys' club should be founded by the non-ferrous metals trade, and said that, spread over a number of contributors, only a small sum would be required from each to launch a club permanently associated with the industry.

At this luncheon meeting a collection was taken on behalf of the Federation of Boys' Clubs, and the sum of £13 was realized.

Industrial Safety

Readers are reminded that the **1959 Safety and Factory Efficiency Exhibition** opens at the Bingley Hall, Birmingham, on Friday of next week (June 19) and will continue until June 26. Various types of safety appliances, clothing, and protective equipment will be on view and special exhibits will specifically deal with safety devices in the building industry. The exhibition is sponsored by the Birmingham and District Industrial Safety Group.

All-Basic Furnaces

Following a series of successful basic roof trials on 300/350 ton tilting open-hearth furnaces, the Appleby-Frodingham Steel Co. Ltd., have now firmly established the All-Basic Furnace to the extent that 7 furnaces have now been converted.

These trials at the Appleby-Frodingham Steelworks have given the British basic brick makers full scope for the development of the fired chrome-magnesite and magnesite chrome brick for use under extremely arduous conditions imposed by operating at temperatures in excess of 1,700°C. and to a fully sprung design.

Until recently the roof life records on these furnaces was held jointly by one Austrian and one British brickmaker with lives of 144 and 139 days respectively; but now the Spinella R2 brick produced by **General Refractories Limited** has given a life of 167 days during which time over 70,000 tons of steel was produced. The results show that Great Britain leads the world in the quality of its basic bricks.

Change of Address

It has been announced by **British Insulated Callender's Cables Ltd.** that the address of their Lincoln branch is now Holmes Road, Lincoln, with the telephone number of Lincoln 21351.

Aluminium in Eire

A new aluminium factory built by Messrs. Unidare Ltd., at Finglas, Dublin, has gone into production and is making aluminium foil for wrappings, milk bottle and other bottle tops, copper and aluminium extrusions, window sections, as well as a wide range of domestic goods. The new factory is erected on a 60-acre site.

It is planned to supply the entire needs of the Republic in foil and metal tops for bottles. Hitherto all foil and metal tops had to be imported, and the trade was stated to be worth about half a million pounds.

Aluminium Tower

A 103 ft. high tower, built up from standard aluminium-alloy staging sections, has been erected at Hemel Hempstead, Herts., to demonstrate the potentialities of this system of construction for permanent or demountable towers to support antennae for radar or micro-wave systems.

This "Zip-Up" stairway tower is built up from a series of interchangeable folding sections which, when opened out, form rigid box frames each incorporating its own stairway. These 100 lb. frames are automatically held square and secure by the diagonal stairway and by braces which are provided with patented snap-on locking hooks. Successive sections are interlocked one on top of the other by spigots which register in the tops and bottoms of the vertical corner tubes. After the 18 ft. level is reached, the pre-assembled sections are hoisted up by a davit which is hooked to the top of the tower and moved up progressively.

Construction of the sections, which are manufactured by Access Equipment Ltd., of Maylands Avenue, Hemel Hempstead, Herts., under licence from Upright Scaffold Inc., U.S.A., relies upon the close tolerance of extruded round tubing in various sizes in Noral B51 SWP (B.S. HV30WP) alloy supplied by **Northern Aluminium Company Ltd.,** and cast aluminium-alloy couplings to B.S. LM10M, which incorporate a special locking device. Every corner and tubular connection is made with four substantial welds.

U.S. Lead Industry

New supply of lead in the United States totalled 105,700 short tons in March, and 85,100 tons was consumed, according to the Bureau of Mines, United States Department of the Interior. Primary refineries produced 35,000 tons of refined lead and 3,900 tons of lead in antimonial lead; secondary lead and copper smelters reclaimed 32,000 tons; and 34,800 tons of pigs and bars were imported. Mine production of recoverable lead (21,000 tons) was slightly less than in February.

A half cent increase on March 5 brought the quoted New York price of common lead to 11·50 cents a pound, where it remained until April 1.

Reversing the trend of past months, primary producers shipped more refined lead and antimonial lead than they produced in March. Production of 35,000 tons of refined lead and shipment of 39,500 tons decreased refinery stocks 2 per cent to 198,400 tons—the first inventory reduction since October 1958. Antimonial lead inventories were also slightly lower at the end of the month.

Consumption of lead-base and tin-base scrap and secondary and primary lead smelters totalled 43,200 tons—a decrease of 14 per cent compared with February. Smelters treated 23,000 tons of battery lead plates, which accounted for 53 per cent of all scrap smelted. Stocks of lead-base scrap decreased 7 per cent during the month to 37,400 tons. Inventories of tin-base scrap rose 9 per cent to total 700 tons on March 31.

From the scrap consumed in March, 31,300 tons of secondary metals were recovered—29,400 tons of lead, 700 tons of tin, and 1,200 tons of antimony. Recovery was 8 per cent lower than in February. Primary lead smelters reclaimed 2,400 tons of the lead and 34 tons of the antimony, and secondary lead smelters recovered the remainder.

Indian Mineral Production

Provisional estimates made by the Indian Bureau of Mines place the total value of 1958 Indian mineral production (excluding petroleum and minerals prescribed under the Atomic Energy Act, 1948) at 1,310 million rupees, compared with 1,273 million rupees in 1957. The increase of 37 million rupees, the Bureau said, was mainly due to higher production of coal, salt, iron ore, mica, limestone and ilmenite in the year under review. Coal, with an output of about 46·1 million metric tons, was the leading commodity, and was valued at 866 million rupees.

The production of other minerals was: copper ore, 411,000 metric tons; gold, 5,288 kilograms; ilmenite, 314,000 metric tons; iron ore, 6 million metric tons; limestone, 10·3 million metric tons; manganese ore, 1·2 million metric tons; mica (crude), 31,802 metric tons; and salt, 4·2 million metric tons.

Men and Metals

Changes in the board of directors of Vickers Limited have been announced as follows:—**Sir James Reid Young,** C.A., F.C.I.S., having reached normal retirement age, has vacated his seat on the board. **Mr. W. D. Opher,** M.I.Mech.E., a director of Vickers-Armstrongs Limited and of certain other group companies, and managing director of Vickers-Armstrongs (Engineers) Limited, has been appointed an additional director of the company.

News from Amber Oils Limited, a member of the Amber Group of Companies, is that **Mr. C. A. B. Malden** has been appointed joint managing director of the company with Mr. J. G. Cronk. Mr. Malden joined the company in 1958 from Stephenson Clarke Limited.

New appointments to the board of High Duty Alloys Limited, a member of the Hawker Siddeley Industries Limited have been announced as follows:—**Mr. J. F. Robertson,** C.A., a director and group treasurer of the Hawker Siddeley Group, and **Mr. Ian C. Dick,** C.A., who joined the company in June 1952 as chief accountant and was appointed company secretary in 1954, a position which he still retains.

Metal Market News

EVENTS last week showed clearly enough that a simple increase in the stocks of standard copper in L.M.E. warehouses is not sufficient to clear up a condition of backwardation on the market. As was rather expected, Monday brought news of a rise of no less than 1,382 tons in the tonnage lying in warehouse, the adjusted total being 12,898 tons. Moreover, it seems quite possible that this upward trend will continue, for a time at any rate, while in the event of no strike taking place there may not be much pause in the rising tonnage of reserves of standard copper over the rest of this year. True, the backwardation narrowed to 10s. on Tuesday, and further to 5s. on the following day at the midday session, but at the afternoon unofficial session it widened again to 15s. The fact is that, in addition to adequate stocks, it is essential that warrants should circulate freely. Stocks might be as high as 20,000 tons, but if the majority of the warrants are not well distributed, and, indeed, are held in one direction, then there is real danger of something like a squeeze. Matters are much better, however, if there is a willingness to lend to the market so as to overcome any tendency to a famine situation in cash metal. At the moment the market seems to be reluctant to return to a contango, but it may well be that once a premium for the forward position is established, a return to a backwardation will not occur easily, even though there should be a reduction in stocks.

Despite the decision by the Tin Council to permit an increase in the export quotas for the third quarter of this year, the tendency of the quotation for standard tin last week was upwards and a steady advance, even though a modest one, took place during the first three days. Stocks in L.M.E. warehouses continued to fall, and at the beginning of last week it was announced that the reserves of standard tin in warehouse had declined by 451 tons to 7,664 tons. The fall in stocks has now been going on for several weeks and it is thought that the Buffer Pool has been able to reduce its holding substantially. Demand last week certainly seemed to be sufficient to absorb all the Buffer Stock offerings which came along. By the middle of the week the quotation had risen to £789 three months, which was £3 10s. 0d. higher than the previous Friday, and a contango of 10s. was seen on the afternoon market. At the close of business last Friday, the prices were £787 10s. 0d. for cash and £789 three months, which showed a gain on the week of £2 for cash. Tin is again commanding quite a bit of attention, and the increase in activity suggests that operators are using the market more freely for hedging than was the case a few months ago. The turnover for the week was 1,620 tons.

A feature in the lead market last week was the burst of activity on Wednesday, when the turnover for the day amounted to 3,125 tons, an altogether exceptional tonnage. Little variation in price was seen, however, and indeed it could be said that on the whole trading in this metal was featureless. In total, last week accounted for a turnover of 6,800 tons, closing prices being £69 10s. 0d. for June and £71 for September. On balance, June lost 7s. 6d. while September lost 12s. 6d. Like lead, zinc was a somewhat vacillating market, which, after a turnover of 4,450 tons, resulted in a closing quotation of £77 for June and £76 September. This meant on balance that June closed 30s. lower while September lost 25s. Trading in standard copper was active, and the turnover was close on 13,000 tons without business on the Kerb. U.S. stockpile uncertainties exercised a bearish influence on Friday and the close was rather weak at £236 10s. 0d. cash and £235 5s. 0d. three months. On balance this meant a loss of £5 in cash and of £5 5s. 0d. in the forward quotation.

Birmingham

Metal-using industries in the Midlands continue to make progress, and for the next few weeks, until the annual holiday, demand for raw materials seems likely to be maintained, and probably expanded. The outlook is more confident than it has been for a long time. The motor trade continues its record-making production, and many small firms doing plating and polishing work for the trade are assured of full employment for the next few months, at least. Makers of pressings and stampings are actively employed. There is more work in the building trade, especially on the erection of new shopping centres in the cities, but the rate of factory building has slowed down this year, and fewer licences have been granted by the Board of Trade.

Buyers of iron and steel are still buying, for the most part, in small tonnages rather than on a long-term basis. The heavy steel industry dealing in structural products is in need of a stimulus, and the foundries are still operating below capacity. Nevertheless, the position is much more satisfactory than it was six months ago. Re-rollers are working more shifts following the receipt of bigger orders for light sections. The sheet mills catering for the motor trade are fully employed, and there is a big demand for steel from the railways for replacement of rails, and in connection with electrical engineering schemes. Although the number of furnaces making pig iron is smaller than it has been for some years, the output more than covers demand.

New York

The *Journal of Commerce* has forecast a battle between the United States Administration and the Senate on the issue of whether the national stockpile of strategic commodities should be reduced or frozen. The Administration is working out a formula to dispose of vast amounts of these metals and minerals, while the Senate is moving to ensure that stocks will never be dumped into the open market. According to the paper, the Senate Appropriations Committee is generally conceded to be more responsive to the fears of basic commodity producers. On the other hand, the House Appropriations Committee has given ample evidence of its dissatisfaction with the huge expense involved in acquiring and maintaining the stockpiles.

The Appropriations Committee recently set the stage for a sell-off of some of the stockpiled items after being prodded by the Administration, which estimates about 4,000 million dollars of the total 8,000 million dollars inventory exceeds anticipated emergency needs. By refusing to give the General Services Administration 49 million dollars to rotate deteriorating rubber, fibres and oils in the stockpiling during the fiscal year 1960, it ordered, in effect that the G.S.A. dispose of these items and not replace them.

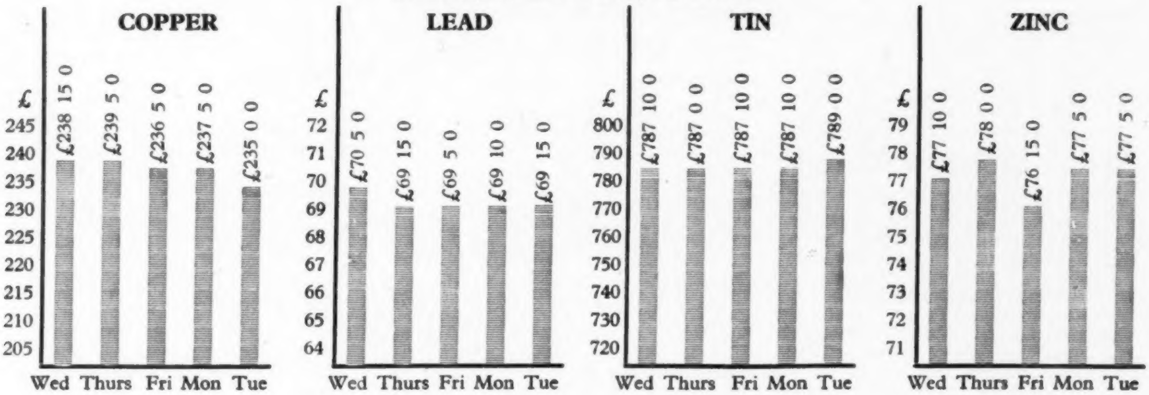
The Committee also refused to reappropriate unspent 1959 fiscal year G.S.A. funds. This will give the Administration a chance to come to Congress in 1960 with a programme to cut the stockpile back to manageable proportions, the paper said. In fact, the *Journal of Commerce* adds, the Administration is making another attempt at coming up with a plan to start unloading surpluses.

The Government's chief stockpile policy-maker, Mr. Leo A. Hoegh, has informed the Senate House Joint Defence Production Committee that the Administration is revising its stockpile policy, the journal says. But 13 Senators have introduced legislation to "lock up" the Defence Production Act Inventories, sparked by a reported Administration move to sell 128,000 tons of D.P.A. copper in the open market. The object of the Bill is to require approval of Congress before any D.P.A. goods can be disposed of.

Non-Ferrous Metal Prices

London Metal Exchange

Wednesday 3 June to Tuesday 9 June 1959



Primary Metals

All prices quoted are those available at 2 p.m. 9/6/59

		£	s.	d.
Aluminium Ingots	ton	180	0	0
Antimony 99·6%	„	197	0	0
Antimony Metal 99%	„	190	0	0
Antimony Oxide	„	180	0	0
Antimony Sulphide Lump	„	190	0	0
Antimony Sulphide Black Powder	„	205	0	0
Arsenic	„	400	0	0
Bismuth 99·95%	lb.		16	0
Cadmium 99·9%	„		9	0
Calcium	„	2	0	0
Cerium 99%	„	16	0	0
Chromium	„		6	11
Cobalt	„		14	0
Columbite	per unit		—	
Copper H.C. Electro	ton	235	0	0
Fire Refined 99·70%	„	234	0	0
Fire Refined 99·50%	„	233	0	0

		£	s.	d.
Copper Sulphate	ton	76	0	0
Germanium	grm.		—	
Gold	oz.	12	9	9
Indium	„		10	0
Iridium	„	24	0	0
Lanthanum	grm.		15	0
Lead English	ton	69	15	0
Magnesium Ingots	lb.		2	3
Notched Bar	„		2	9½
Powder Grade 4	„		6	1
Alloy Ingot, A8 or AZ91	„		2	4
Manganese Metal	ton	245	0	0
Mercury	flask	77	0	0
Molybdenum	lb.	1	10	0
Nickel	ton	600	0	0
F. Shot	lb.		5	5
F. Ingot	„		5	6
Osmium	oz.		nom.	
Osmiridium	„		nom.	

		£	s.	d.
Palladium	oz.	7	5	0
Platinum	„	28	10	0
Rhodium	„	41	0	0
Ruthenium	„	18	0	0
Selenium	lb.		nom.	
Silicon 98%	ton		nom.	
Silver Spot Bars	oz.		6	6½
Tellurium	lb.		15	0
Tin	ton	789	0	0
***Zinc**				
Electrolytic	ton		—	
Min 99·99%	„		—	
Virgin Min 98%	„	76	16	3
Dust 95/97%	„	109	0	0
Dust 98/99%	„	115	0	0
Granulated 99+%	„	101	16	3
Granulated 99·99+%	„	115	3	9

**Duty and Carriage to customers' works for buyers' account.*

Foreign Quotations

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

	Belgium fr/kg	≏£/ton	Canada c/lb	≏£/ton	France fr/kg	≏£/ton	Italy lire/kg	≏£/ton	Switzerland fr/kg	≏£/ton	United States c/lb	≏£/ton
Aluminium			22.50	185 17 6	224	165 0	375	221 5	2.50	212 10	26.80	214 10
Antimony 99.0					220	163 0	445	262 10			29.00	232 0
Cadmium					1,350	1,012 10					130.00	1,040 0
Copper												
Crude												
Wire bars 99.9							460	271 10 0				
Electrolytic	33.25	244 15 0	30.50	252 0	334	250 10			3.00	255 0*	31.50	252 0
Lead			10.25	84 12 6	103	78 0	166	97 17 6	.88	74 17 6	12.00	96 0
Magnesium												
Nickel			70.00	578 5	900	675 0	1,200	708 0	7.50	637 10	74.00	592 0
Tin	111.50	820 17 6			1,126	844 10	1,500	885 0	9.70	824 12 6	104.62	836 17 6
Zinc												
Prime western			11.25	92 17 6							11.00	88 0
High grade99.95			11.85	94 0 0								
High grade99.99			12.25	101 2 6								
Thermic					115.00	86 5						
Electrolytic					123.00	92 5	176	103 17 6	1.02	86 17	12.25	98 0

c

Non-Ferrous Metal Prices (continued)

Ingot Metals

All prices quoted are those available at 2 p.m. 9/6/59

Aluminium Alloy (Virgin)		£	s.	d.
B.S. 1490 L.M.5	ton	210	0	0
B.S. 1490 L.M.6	„	202	0	0
B.S. 1490 L.M.7	„	216	0	0
B.S. 1490 L.M.8	„	203	0	0
B.S. 1490 L.M.9	„	203	0	0
B.S. 1490 L.M.10....	„	221	0	0
B.S. 1490 L.M.11....	„	215	0	0
B.S. 1490 L.M.12....	„	223	0	0
B.S. 1490 L.M.13....	„	216	0	0
B.S. 1490 L.M.14....	„	224	0	0
B.S. 1490 L.M.15....	„	210	0	0
B.S. 1490 L.M.16....	„	206	0	0
B.S. 1490 L.M.18....	„	203	0	0
B.S. 1490 L.M.22....	„	210	0	0
†Aluminium Alloys (Secondary)				
B.S. 1490 L.M.1	ton	153	0	0
B.S. 1490 L.M.2	„	163	0	0
B.S. 1490 L.M.4	„	178	0	0
B.S. 1490 L.M.6	„	189	0	0
***Aluminium Bronze**				
BSS 1400 AB.1......	ton	—		
BSS 1400 AB.2......	„	—		

*Brass		£	s.	d.
BSS 1400-B3 65/35 ..	ton	—		
BSS 249...........	„	—		
BSS 1400-B6 85/15 ..	„	—		
***Gunmetal**				
R.C.H. 3/4% ton	„	—		
(85/5/5/5) LG2	„	—		
(86/7/5/2) LG3	„	—		
(88/10/2/1)	„	—		
(88/10/2/½)	„	—		
***Manganese Bronze**				
BSS 1400 HTB1....	„	—		
BSS 1400 HTB2....	„	—		
BSS 1400 HTB3....	„	—		
Nickel Silver				
Casting Quality 12%	„	223	0	0
„ „ 16%	„	235	0	0
„ „ 18%	„	245	0	0
***Phosphor Bronze**				
B.S. 1400 P.B.1.(A.I.D. released)	„	—		
B.S. 1400 L.P.B.1	„	—		

**Average prices for the last week-end.*

Phosphor Copper		£	s.	d.
10%	ton	256	0	0
15%	„	258	10	0
Phosphor Tin				
5%	„	—		
Silicon Bronze				
BSS 1400-SB1	„	245	0	0
Solder, soft, BSS 219				
Grade C Tinmans....	„	365	15	0
Grade D Plumbers..	„	294	0	0
Grade M	„	401	15	0
Solder, Brazing, BSS 1845				
Type 8 (Granulated)	lb.	—		
Type 9 „	„	—		
Zinc Alloys				
Mazak III	ton	108	8	9
Mazak V	„	112	8	9
Kayem	„	118	8	9
Kayem II	„	125	11	3
Sodium-Zinc	lb.		2	6⅛

Semi-Fabricated Products

Prices vary according to dimensions and quantities. The following are the basis prices for certain specific products.

Aluminium				
Sheet 10 S.W.G.	lb.		2	8⅛
Sheet 18 S.W.G.	„		2	10⅛
Sheet 24 S.W.G.	„		3	1⅛
Strip 10 S.W.G.	„		2	8⅛
Strip 18 S.W.G.	„		2	9⅛
Strip 24 S.W.G.	„		2	11
Circles 22 S.W.G.	„		3	2⅛
Circles 18 S.W.G.	„		3	1⅛
Circles 12 S.W.G.	„		3	0⅛
Plate as rolled	„		2	8
Sections	„		3	2
Wire 10 S.W.G.	„		2	11⅛
Tubes 1 in. o.d. 16 S.W.G.	„		4	1
Aluminium Alloys				
BS1470. HS10W.				
Sheet 10 S.W.G.	„		3	1
Sheet 18 S.W.G.	„		3	3½
Sheet 24 S.W.G.	„		3	11
Strip 10 S.W.G.	„		3	1
Strip 18 S.W.G.	„		3	2½
Strip 24 S.W.G.	„		3	10½
BS1477. HP30M.				
Plate as rolled......	„		2	11
BS1470. HC15WP.				
Sheet 10 S.W.G.	„		3	9½
Sheet 18 S.W.G.	„		4	2
Sheet 24 S.W.G.	„		5	0⅛
Strip 10 S.W.G.	„		3	10⅛
Strip 18 S.W.G.	„		4	2
Strip 24 S.W.G.	„		4	9½
BS1477. HPC15WP.				
Plate heat treated..	„		3	6⅛
BS1475. HG10W.				
Wire 10 S.W.G.	„		3	10½
BS1471. HT10WP.				
Tubes 1 in. o.d. 16 S.W.G.	„		5	0½
BS1476. HE10WP.				
Sections	„		3	1½
Brass				
Tubes..............	„		1	10¾
Brazed Tubes........	„		3	0¼
Drawn Strip Sections	„		—	
Sheet	ton	200	10	0
Strip	„	200	10	0
Extruded Bar........	lb.		2	0½
Extruded Bar (Pure Metal Basis)	„		—	

Brass				
Condenser Plate (Yellow Metal)	ton	194	0	0
Condenser Plate (Naval Brass)	„	206	0	0
Wire	lb.		2	8¼
Beryllium Copper				
Strip	„	1	4	11
Rod................	„	1	1	6
Wire	„	1	4	9
Copper				
Tubes	lb.		2	4
Sheet	ton	269	5	0
Strip	„	269	5	0
Plain Plates	„		—	
Locomotive Rods	„		—	
H.C. Wire	„	288	5	0
Cupro Nickel				
Tubes 70/30	lb.		3	7⅜

Lead				
Pipes (London)	ton	111	5	0
Sheet (London)	„	109	0	0
Tellurium Lead	„	£6 extra		
Nickel Silver				
Sheet and Strip 7% ..	lb.		3	8
Wire 10%	„		4	2¼
Phosphor Bronze				
Wire	„		4	1⅜
Titanium (1,000 lb. lots)				
Billet 4½″ to 18″ dia...	lb.	54/-	55/-	
Rod ¼″ to 4″ dia.	„	95/-	62/-	
Wire ·036″ – ·232″ dia.	„	167/-	110/-	
Strip ·003″ to ·048″ ..	„	200/-	75/-	
Sheet 8′×2′. 20 gauge	„	85/-		
Tube, representative average gauge......	„	300/-		
Extrusions	„	105/-		
Zinc				
Sheet	ton	112	5	0
Strip	„	nom.		

Domestic and Foreign

Merchants' average buying prices delivered, per ton, 8/6/59.

Aluminium	£
New Cuttings	146
Old Rolled	126
Segregated Turnings	98
Brass	
Cuttings	160
Rod Ends	150
Heavy Yellow	125
Light	121
Rolled	152
Collected Scrap	124
Turnings	142
Copper	
Wire	216
Firebox, cut up	210
Heavy	206
Light	201
Cuttings	216
Turnings	200
Braziery	163

Gunmetal	£
Gear Wheels	185
Admiralty..................	185
Commercial................	166
Turnings	161
Lead	
Scrap	60
Nickel	
Cuttings	—
Anodes	550
Phosphor Bronze	
Scrap	166
Turnings	161
Zinc	
Remelted	69
Cuttings	53
Old Zinc	37

Financial News

U.S. Silicon Prices Reduced

Towards last week-end advices from New York stated that bulk silicon prices had been reduced about 2½ cents per pound as the result of sharp competition from imported material. No official price reductions had been posted by leading domestic producers although it was reported in the industry that they were meeting competitive prices.

Davy-United Ltd.

As a result of the growth of the company the board of directors are proposing a new Group organization aimed at effecting a certain degree of decentralization. These proposals, to be placed before an extraordinary General Meeting of the company later this month, will include the formation of a number of wholly-owned subsidiaries, each undertaking a particular field of manufacture.

The company previously trading as Davy and United Engineering Company Ltd. will now become the Holding company of the group, with the new name of Davy-United Ltd. At present two new subsidiaries are to be formed, the first of which will be called Davy and United Engineering Company Ltd., thus retaining the goodwill attaching to that name, and will carry on all the main engineering activities of the group. This subsidiary will comprise the Darnall works at Sheffield (excluding the instrument shops), the Glasgow works in Bridgeton and the Construction Division with headquarters at Brantwood, Sheffield.

The second new subsidiary will be called Davy and United Instruments Ltd., and this will undertake the work at present handled by the instrument division in the development and manufacture of a range of electronic and radiation type instruments for the automatic control of rolling mills, etc. The manufacture of rolls and steel castings will continue to be carried out at Billingham by Davy and United Roll Foundry Ltd, which is also a wholly-owned subsidiary.

The Board also proposes to capitalise reserves equal in amount to the present issued capital of £1,509,528 by an allotment to members on a four-for-one basis of new fully paid shares to the above amount. A substantial part of the money required to finance the very considerable growth of the group during the past 12 years has been found from retained profits.

New Companies

The particulars of companies recently registered are quoted from the daily register compiled by Jordan and Sons Limited, Company Registration Agents, Chancery Lane, W.C.2.

Eric Williams (Metal Products) Limited (628292), Pinfold Lane, Penkridge, Staffs. Registered May 15, 1959. Nominal capital, £2,000 in £1 shares. Directors: Eric Williams and Mrs. E. F. D. Williams.

A. Owen and Sons Limited (628476), 233 Richmond Road, Sheffield, 13. Registered May 20, 1959. To take over business of furnace builders and annealers, grinders and welders, carried on as "A. Owen and Sons" at Sheffield etc. Nominal capital, £3,000 in £1 shares. Directors: Alfred Owen, senr., Alfred Owen, junr., and Frank Owen.

Planet Polishing Company Limited (628559), 33a Green Lane, Walsall. Registered May 21, 1959. To carry on business of polishing manufactured metal articles of all kinds, etc. Nominal capital, £2,000 in £1 shares. Directors: Richard C. Ireland and Sarah J. Ireland.

Manderstam, Lowe and Partners Limited (628708), 38 Grosvenor Gardens, S.W.1. Registered May 25, 1959. To carry on business of consultants, advisers, designers to engineers, metallurgists, chemists, architects, pulp, paper and cloth manufacturers, etc. Nominal capital, £100 in £1 shares. Directors: Leopold H. Manderstam, Peter H. Wilson and James C. Lowe.

E. Pownall and Co. Limited (628833), Manvers Street, Nottingham. Registered May 26, 1959. To carry on business of scrap metal merchants, etc. Nominal capital, £2,000 in £1 shares. Directors: Edgar A. Pownall, Victor A. Pownall, Sheila Goode, James H. Goode and Mrs. S. M. Pownall.

S. G. Owen Limited (628953), 23 Oak Street, Northampton. Registered May 27, 1959. To carry on business of specialists in electrodeposition and surface treatment of metals, etc. Nominal capital, £20,000 in £1 shares. Permanent directors: Winifred M. Owen and John M. Cockeram.

Trade Publications

Thread Rolling Dies. — W. H. A. Robertson and Co. Ltd., Lynton Works, Bedford.

The latest addition to their series of "Guides" is the Robertson Guide to Thread Rolling, which covers some 28 pages and is designed primarily to help users of thread rolling equipment by providing a wealth of fully illustrated technical information. This present publication deals with the thread rolling process, technical definitions and rolling equipment. Much other useful information is included, such as statistical data and a number of illustrations.

Pretreatment.—Imperial Chemical Industries Ltd., London and Birmingham.

The latest issue of this publication contains an interesting article on developments in phosphating, being a Paper read at the Spring Conference of the Institute of Metal Finishing by Mr. R. E. Shaw, B.Sc., F.I.M., of the I.C.I. Paints Division. There are also illustrated articles demonstrating the use of I.C.I. pretreatment preparations in certain buildings.

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THE PUBLISHING DEPT., DORSET HOUSE, STAMFORD ST., LONDON, S.E.1

Scrap Metal Prices

The figures in brackets give the English equivalents in £1 per ton:—

West Germany (D-marks per 100 kilos):		
Used copper wire	(£210.5.0)	240
Heavy copper	(£210.5.0)	240
Light copper	(£183.17.6)	210
Heavy brass	(£122.15.0)	140
Light brass	(£92.0.0)	105
Soft lead scrap	(£57.0.0)	65
Zinc scrap	(£36.15.0)	42
Used aluminium unsorted	(£83.5.0)	95
France (francs per kilo):		
Electrolytic copper scrap	(£195.0.0)	260
Heavy copper	(£195.0.0)	260
No. 1 copper wire	(£183.15.0)	245
Light brass	(£112.12.6)	150
Zinc castings	(£50.2.6)	67
Lead	(£69.0.0)	92
Aluminium	(£131.2.6)	175

Italy (lire per kilo):		
Aluminium soft sheet clippings (new)	(£197.12.6)	335
Aluminium copper alloy	(£126.17.6)	215
Lead, soft, first quality	(£75.12.6)	128
Lead, battery plates	(£41.17.6)	71
Copper, first grade	(£215.10.0)	365
Copper, second grade	(£203.2.6)	345
Bronze, first quality machinery	(£200.15.0)	340
Bronze, commercial gunmetal	(£171.2.6)	290
Brass, heavy	(£138.15.0)	235
Brass, light	(£123.17.6)	210
Brass, bar turnings	(£127.0.0)	215
New zinc sheet clippings	(£60.2.6)	102
Old zinc	(£45.10.0)	77

THE STOCK EXCHANGE

Profit Taking Caused A Certain Amount Of Reaction. Jenks Touched 17/6 On Delta Offer

ISSUED CAPITAL ●	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 8 JUNE +RISE—FALL	DIV. FOR LAST FIN. YEAR	DIV. FOR PREV. YEAR	DIV. YIELD	1959 HIGH	1959 LOW	1958 HIGH	1958 LOW
£	£			Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation ...	27/-xd —1½d.	9	9	6 13 3	27/3	23/3	24/9	17/6
400,000	2/-	Anti-Attrition Metal	1/3	4	8½	6 8 0	1/6	1/3	1/9	1/3
41,303 829	Stk. (£1)	Associated Electrical Industries ...	59/3xd —2/6	15	15	5 1 3	62/-	54/-	58/9	46/6
1,613,280	1	Birfield	51/3 +2/6	15	15	5 17 0	59/	47/-	62/4½	46/3
3,196,667	1	Birmid Industries	79/- —2/9	17½	17½	4 4 3	81/9	72/-	77/6	55/3
5,630,344	Stk. (£1)	Birmingham Small Arms	44/-xd +7½d.	11	10	5 0 0	44/1½	36/1½	39/-	23/9
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	15/6	5	5	6 9 0	16/3	15/-	16/1½	14/7½
350,580	Stk. (£1)	Ditto Cum. B. Pref. 6%	17/9	6	6	6 15 3	18/1½	17/9	17/4½	16/6
500,000	1	Belton (Thos.) & Sons	32/6	10	10	6 3 0	32/6	27/6	28/9	24/-
300,000	1	Ditto Pref. 5%	15/3 —3d.	5	5	6 11 3	15/6	15/-	16/-	15/-
160,000	1	Booth (James) & Co. Cum. Pref. 7%	20/6	7	7	6 16 6	20/6	20/-	20/4½	19/-
1,500,000	Stk. (£1)	British Aluminium Co. Pref. 6% ...	19/3 —3d.	6	6	6 4 9	19/7½	18/9	20/-	18/4½
17,247,987	Stk. (£1)	British Insulated Callender's Cables	55/9 +3d.	12½	12½	4 10 6	56/-	47/6	52/6	38/9
17,047,166	Stk. (£1)	British Oxygen Co. Ltd., Ord. ...	58/- —5/3	10	10	3 9 0	64/-	49/3	52/-	28/3
1,200,000	Stk. (5/-)	Canning (W.) & Co.	15/9xcap +3d.	25+*2½C‡	25	3 19 3	32/-	15/6	25/3	19/3
60,484	1/-	Carr (Chas.)	2/6 —1½d.	12½	25	5 0 0	2/7½	1/3	2/3	1/4½
150,000	2/-	Case (Alfred) & Co. Ltd.	7/3	25	25	6 18 0	7/3	4/7½	5/3	4/-
555,000	1	Clifford (Chas.) Ltd.	23/7½ —1½d.	10	10	8 9 6	23/9	22/6	22/-	16/-
45,000	1	Ditto Cum. Pref. 6%	16/-	6	6	7 10 0	16/-	15/3	16/-	15/-
250,000	2/-	Coley Metals	3/1½ —4½d.	15	20	9 12 0	4/-	2/10½	4/6	2/6
10,185,696	1	Cons. Zinc Corp.†	67/6 —1/-	15	18¾	4 8 9	68/6	60/-	65/3	41/-
1,509,528	1	Davy & United	108/9	20	15	3 13 6	113/9	86/-	87/-	45/9
5,830,000	5/-	Delta Metal	17/6 +1½d.	31‡	30	4 8 6	33/7½	16/3	25/-	17/7½
5,296,550	Stk. (£1)	Enfield Rolling Mills Ltd.	54/9 —4½d.	15	12½	5 9 6	57/6	36/7½	38/-	22/9
750,000	1	Evered & Co.	32/6xd	10 §	15 Z	6 3 0	33/3	30/-	30/-	26/
18,000,000	Stk. (£1)	General Electric Co.	33/- —1/9	10P	12½		40/3	30/6	40/6	29/6
1,500,000	Stk. (10/-)	General Refractories Ltd.	36/3 +1/-	20	20	5 10 6	40/-	32/6	39/3	27/3
401,240	1	Gibbons (Dudley) Ltd.	65/-	16½	15	5 1 6	66/6	63/6	67/6	61/-
750,000	5/-	Glacier Metal Co. Ltd.	9/3 +1/9	11½	11½	6 4 3	9/3	6/7½	8/3	5/-
1,750,000	5/-	Glynwed Tubes	19/6 —1/-	20	20	5 2 6	20/6	16/4½	18/1½	12/10½
5,421,049	10/-	Goodlass Wall & Lead Industries ...	37/9 —1/-	13‖	18Z	3 9 0	38/9	28/7½	30/9	17/3
342,195	1	Greenwood & Batley	84/-	20	17½	4 15 3	84/-	75/-	57/9	45/-
396,000	5/-	Harrison (B'ham) Ord.	18/10½	*17½	*15	4 12 9	19/-	14/11½	15/9	11/6
150,000	1	Ditto Cum. Pref. 7%	19/3xd	7	7	7 5 6	—	—	19/9	18/4½
1,075,167	5/-	Heenan Group	8/- —3d.	10	10‡	6 5 0	8/6	7/6	9/7½	6/9
236,958,260	Stk. (£1)	Imperial Chemical Industries ...	37/- —3d.	12Z	10	4 6 6	38/3	33/9	38/-	24/3
34,736,773	Stk. (£1)	Ditto Cum. Pref. 5%	16/6xd +3d.	5	5	6 1 3	17/1½	16/-	17/1½	16/-
14,584,025	**	International Nickel	165¾ —¼	$2.60	$3.75	2 18 0	171	153	169	132¾
860,000	5/-	Jenks (E. P.), Ltd.	16/4½ +5/3	14	27½ϕ	4 5 6	17/6	8/9	10/-	6/7½
300,000	1	Johnson, Matthey & Co. Cum. Pref. 5%	16/3	5	5	6 3 0	16/3	15/4½	16/9	15/-
3,987,435	1	Ditto Ord.	61/- +1/-	10	10	3 5 6	61/-	44/3	47/-	36/6
600,000	10/-	Keith, Blackman	30/-	17½E	15	5 16 9	30/-	25/-	28/9	15/-
320,000	4/-	London Aluminium	5/9	10	10	6 19 3	6/4½	5/3	6/-	3/-
765,012	1	McKechnie Brothers Ord.	41/3 +6d.	15	15	7 5 6	45/-	41/3	45/-	32/-
1,530,024	1	Ditto A Ord.	39/3 +6d.	15	15	7 12 9	43/6	38/9	45/-	30/-
1,108,268	5/-	Manganese Bronze & Brass	14/10½ —7½d.	20⅝	20	7 0 0	16/3	13/9	14/1½	8/9
50,628	6/-	Ditto (7½% N.C. Pref.)	6/-	7½	7½	7 10 0	—	—	6/3	5/6
13,098,855	Stk (£1)	Metal Box	85/9 +9d.	11	11	2 11 3	85/9	66/6	73/3	40/6
415,760	Stk. (2/-)*	Metal Traders	10/3 +3d.	50	50	9 15 0	10/3	8/4½	9/-	6/3
160,000	1	Mint (The) Birmingham	25/-	10	10	8 0 0	25/-	22/-	22/9	19/-
80,000	5	Ditto Pref. 6%	73/-	6	6	8 4 6	75/6	69/-	83/6	69/-
3,705,670	Stk. (£1)	Morgan Crucible A	49/9 +3/3	10	10	4 0 6	49/9	43/6	45/-	34/-
1,000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref. ...	17/6	5½	5½	6 5 9	18/6	17/6	18/-	17/-
2,200,000	Stk. (£1)	Murex	42/- —2/6	17½	20	8 6 9	50/-	42/-	58/9	46/-
468,000	5/-	Ratcliffs (Great Bridge)	9/10½ +4½d.	10R	10	3 16 0	11/6	9/6	11/1½	6/10½
234 960	10/-	Sanderson Bros. & Newbould ...	36/-xd	25	20	6 19 0	37/-	27/9	27/3	24/6
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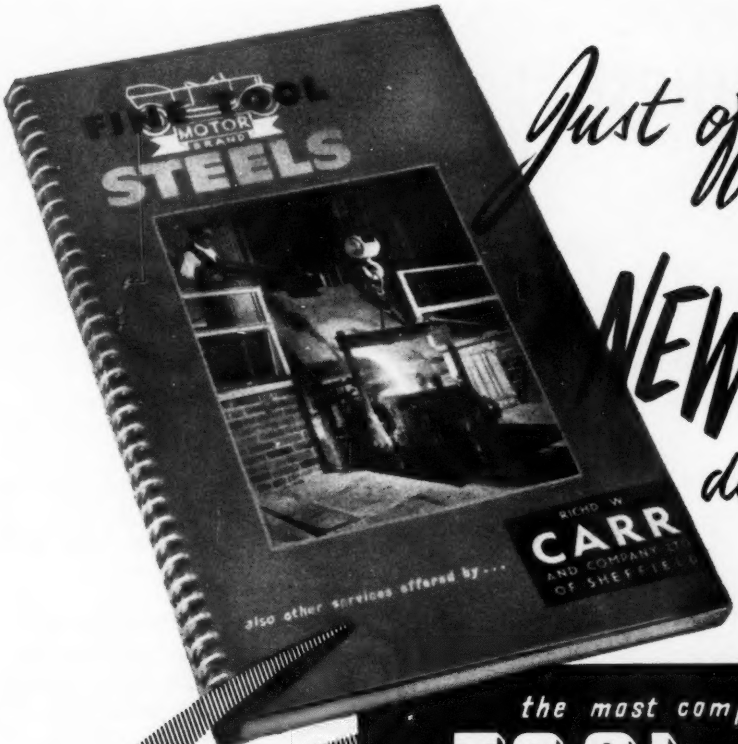

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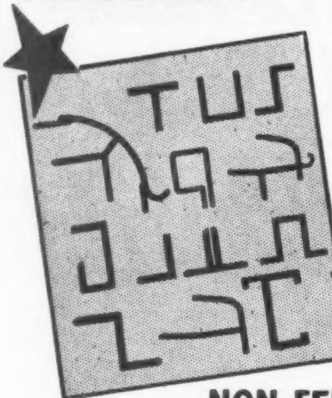

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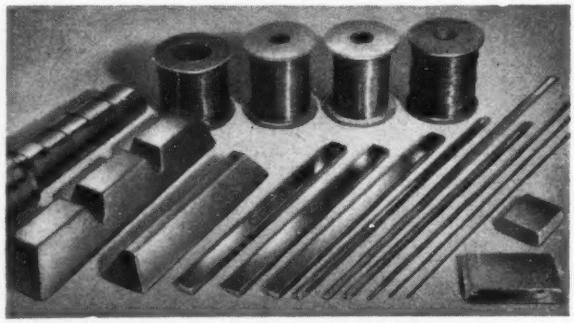

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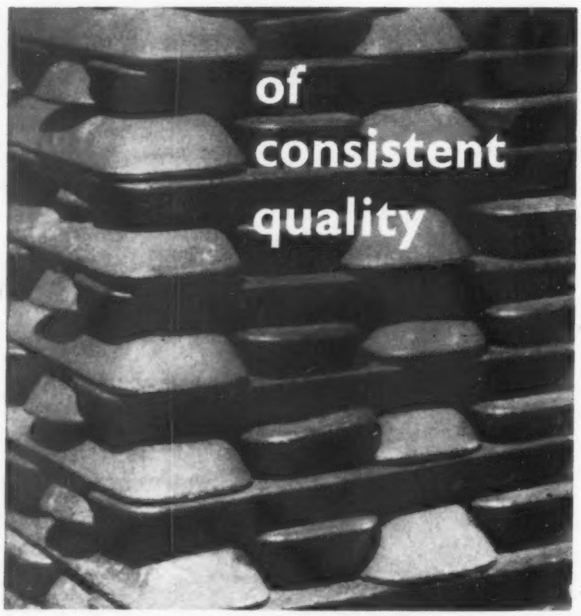

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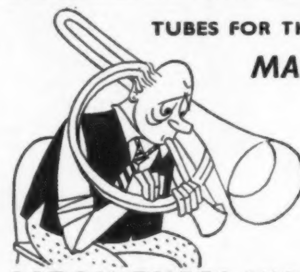

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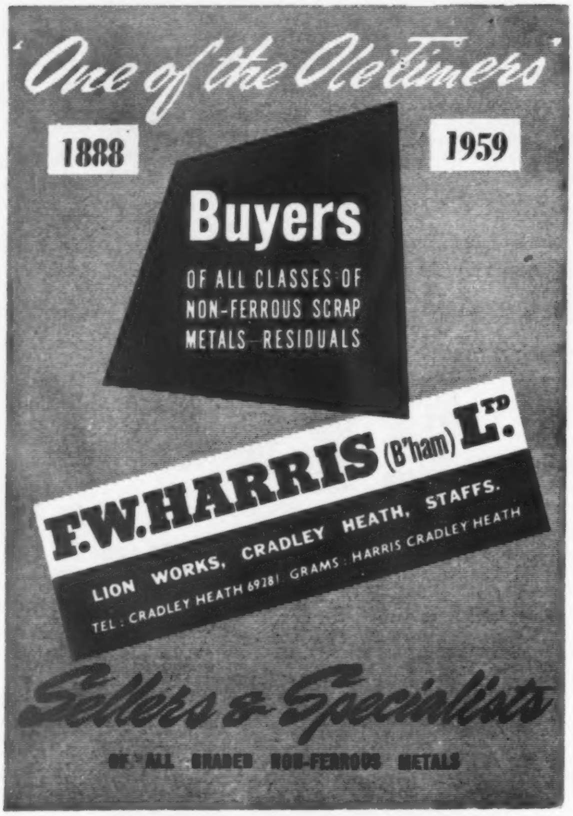

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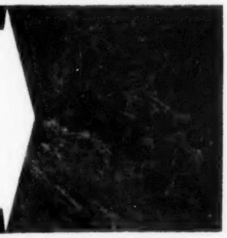

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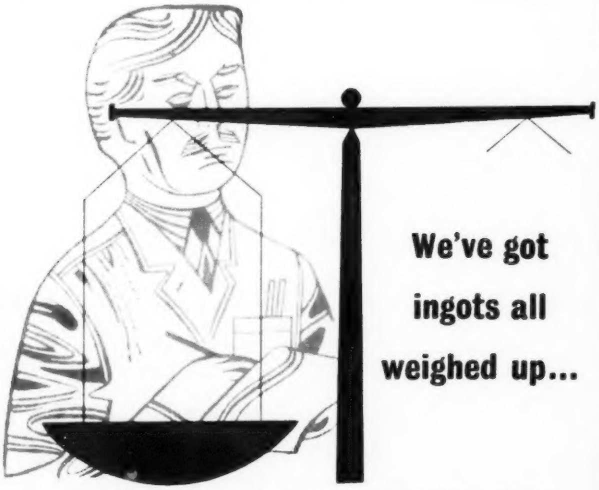

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View showing moulds being poured on Conveyor from 'Roper' Hoist, with Lifting Bail and Crucible Carrier. Bail fitted with side and top protection plates.

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